REPORT ON AGRICULTURAL PROGRAM
AND
APPENDIX TO SURVEY REPORT

BIG BEND-PALOUSE-LOWER SNAKE SUB AREA

COLUMBIA RIVER BASIN AR EA
WASHINGTON, OREGON AND IDAHO

MAY 1954

U. S. D. A.

Report on Agricultural Program
and
Appendix to Survey Report

BIG BEND-PALOUSE-LOWER SNAKE SUB-AREA

COLUMBIA RIVER BASIN AREA

Washington, Oregon and Idaho

For Runoff and Waterflow Retardation and Soil Erosion Prevention for Flood Control Purposes

May 1954

UNITED STATES DEPARTMENT OF AGRICULTURE

Report on Agricultural Program and Appendix to Survey Report
Big Bend-Palouse-Lower Snake Sub-Area
Columbia River Basin Area

This report on the Big Bend-Palouse-Lower Snake sub-area portion of the Columbia River Basin area was prepared under authority of the Flood Control Act, approved June 22, 1936 (Pub. No. 738 - 74th Congress). It was prepared as a part of the agricultural investigations in the Columbia River Basin area that were initiated early in 1950 under the direction of the Secretary of Agriculture's Field Representative and the USDA Field Committee. This committee was composed of representatives of the several administrative heads of U. S. Department of Agriculture agencies, including the land grant colleges.

The report should be considered as two units; Parts I to IV, inclusive, are concerned with the overall agricultural program for the area; Part V is concerned only with those practices and measures which are deemed to have significant values in a flood prevention program. It was originally intended that Part V would serve as an appendix to the survey report on the program for runoff and waterflow retardation and soil erosion prevention to have been submitted to Congress for authorization under the Flood Control Act of 1936.

This report was distributed to the participating Department of Agriculture agencies and land grant colleges in the original draft as it was prepared by the Soil Conservation Service from information provided by the various participating Departmental agencies and other cooperating State and Federal agencies. It was originally planned that the participating Departmental agencies would review this draft of the report and that a revised draft would be prepared, taking into consideration the comments of the several participating agencies.

While this report was being reviewed the "Watershed Protection and Flood Prevention Act" (Public Law 566 - 83rd Congress) was passed by Congress and approved by the President on August 4, 1954. This law repealed the agricultural features of the 1936 Flood Control Act under which the flood prevention program for this sub-area was to have been proposed for authorization by Congress. Consequently, it was deemed inadvisable to spend any more time on the completion of this report than was necessary to provide each participating Department of Agriculture agency with a usable reference.

In view of the circumstances which prevailed at the time, it was questionable if each and every participant reviewed and prepared comments on the draft report with the same degree of care that could have characterized these activities. A copy of the comments which were received from each of the commenting agencies is attached.

No revision was made of the draft report following its review and no attempt was made to adjudicate differing views of the participants on particular points (as reflected by the comments). Obviously then, the information included in and with this report may not be entirely consistent with the official views of the Department or the individual participating agencies.

Review Comments by
Soil Conservation Service
on the
Report on Agricultural Program
and
Appendix to Survey Report
Big Bend-Palouse-Lower Snake Sub-Area
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Page	
I-4 last par. line 4	"Inadequate" should be substituted for "adequate".
I-14 1st full sen.	The flood damage reduction that will be obtained as a result of program installation is reported in table V-17 as being $1,572,649. The figure $332,000 as shown in this sentence is apparently in error.
II-20 1st par.	This statement is inappropriately restrictive as bank cutting occurs on other streams within the area.
II-21 2nd par. 1st sen.	This sentence would indicate that additional lands are being brought under cultivation on the foothill slopes which has not been true to any appreciable extent.
II-44, 45	Sentence completed on page II-45. This sentence should be revised to read "In the semi-arid areas the perennial bunchgrasses can vary in production * * *".
II-50 1st par. last sen.	The effect of the atomic energy program toward increasing the population in this area would appear to be minor as the major development is outside the area and only a small portion of the workers are residents of communities within the area.
III-4 1st par. 4th sen.	The estimate of wheat production exceeding 100 bushels per acre with plentiful moisture is too high. A maximum of 80 bushels per acre under the best management practices would appear to be more reasonable.
III-17 last par. 1st sen.	This sentence should be revised to read: "Tenancy arises in this area largely because of the high capital requirements for owning and operating an economic unit."

Page		
III-37	1st full par. 2nd sen.	This statement appears to be in error in that the trend is toward achieving stability by the consolidation of the smaller ownerships into larger ownerships.
III-43,	2nd par. 2nd sen.	The phrase "rather extensive and expensive structural controls" seems inappropriate in that fencing would be the only requirement other than reseeding and proper management.
III-62	3rd par. 1st sen.	This sentence should be deleted as the statement is erroneous.
III-67	1st par.	The extent of conversion of agricultural land into residential and small part-time farm units is over-emphasized for this area.

Review Comments by
State College of Washington
on the
Report on Agricultural Program
and
Appendix to Survey Report
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Page		
I-1	3rd line	Thatuna Ridge is one part of the Moscow Mountains. This sentence should be changed to read "on the east by the Moscow and Blue Mountain ranges."
	8th line	Question "largely semi-arid". A good portion is sub-humid. Suggest "The climate is temperate, largely semi-arid to sub-humid".
	3rd par. line 1	In the mountainous area to east some of the soils lie on granite, gneiss, and mica schists.
	3rd par. line 6	"grey brown earth" is outmoded. Probably should use "Sierozemic and regosolic" soils.
I-4	3rd line	Suggest "it was in native bunch grass," etc.
	4th line	Suggest deletion of "unlike the existing irrigated lands of deep bottom or bench soils". The phrase is neither true nor needed.
	6th line	Suggest "sandy" rather than "loamy".
	2nd par. line 6	Rewrite: "Adequate on the ground technical assistance, and the need for some further education in the application of research and investigation findings."
	3rd par.	Suggest "The non-irrigated lands of the remainder of the area, broken from native sagebrush fifty to seventy years ago, have suffered somewhat from water and wind erosion, drought, some deline in organic matter and fertility, which has caused some land abuse. Also they have been under the pressure of sustained high production occasioned by two world wars."
I-5	2nd par. line 3	Change to "Chestnut, Chernozem, and Prairie soils.
	3rd par. line 1	Change to "The croplands in the western part of the Palouse area were formerly", etc.
I-6	5th par. line 4	Suggest "Wind and water erosion are active".

Page		
I-8	3rd par. 1st. sen.	Delete. Is argumentative, confusing and really adds nothing to discussion.
I-9	2nd par. line 11	The State College of Washington has an active program of assistance in the area. The Extension Service is active with farm and home planning in the 12 counties, with 44 extension agents in the field. The Washington Agricultural Experiment Station is conducting field research in cooperation with the Agricultural Research Service in the area. Rural Electrification Administration and Farm Credit Administration each have activities and interests in the area.
II-3	line 6	Change "loessial type" to "wind and water laid soils".
II-4	line 1	Change 1,000 feet to 1,300 feet.
	line 6	Change 3,000 feet to 4,000 feet.
II-5	line 10	Either insert "basalt" or change miocene to pleistocene.
II-5a		Soil parent material map is over simplified and confusing. Non-calcareous materials assumed to be largely drift and outwash yet there are more areas than this. Character of sands as to origin could be shown.
III-11		Delete last 2 sentences and substitute this. Each localized area as well as each crop is menaced by weeds which are particularly adapted to the environment. Many weed species persist under non-irrigated cropping, and some of these become more vigorous when the area is put under irrigation. Irrigated cropping also favors the increase of summer germinating annual weeds which are especially harmful to crop production and handling.
III-12		Under first sentence delete "Dalmatian toadflax" and add "Quackgrass, barnyard grass, tarweed, and gromwell".
"	line 8	Delete the word "noxious", and in line 10 change "they" to "some".
III-21, 22		Use of the word "noxious" is not appropriate. Delete "noxious" and revise sentences accordingly.
III-22	line 8	Counties where St. Johnswort is a problem should definitely include Spokane, Stevens, and Pend Oreille as the weed is more widespread in these counties than in those named in the report.

Review Comments by
Forest Service
on the
Report on Agricultural Program
and
Appendix to Survey Report
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Columbia River Basin Area
Washington, Oregon and Idaho

Page	
I-4 line 24	"Adequate" should be "inadequate".
II-45 and Fig. 10	The green area shown on the map as "Douglas-fir" should be "Western white pine".
II-62 line 16	"Fine needle pine" refers to high elevation five-needle pines.
III-31 line 20	"Adequately" should be "already" or "previously".
III-70 2nd sen.	Forest Service does receive notification of intent to patent a claim.
V-24 line 17	Suggest "careful management" instead of "improved logging methods".
V-48 line 13	Suggest omitting the phrase "but not runoff water itself", as unnecessary and confusing.

CHAPTER I

INTRODUCTION

CONTENTS

Table

INTRODUCTION

The Big Bend-Palouse-Lower Snake area occupies the major portion of the Columbia Plateau. It is bounded on the north and west by the Columbia River, on the east by the Thatuna and Blue Mountain ranges, and on the south by the divide between the Walla Walla and Umatilla rivers. The eastern boundary follows timbered, mountainous ridges from which foothills extend into the rolling, dune-like hills of the Palouse Prairie.

The climate is temperate, largely semi-arid, although extreme variations in precipitation occur between the high mountainous boundaries and the western tablelands. Average annual precipitation varies with elevation from about 50 inches in the mountainous eastern part to about 6 inches at the mouth of the Snake River in the western part. The frost-free growing season varies from about 100 to 220 days, averaging 130 days or more in the principal agricultural areas.

The soils lie on Columbia River basalt which in places attains a depth of 5,000 feet. Few of the soils, however, are residual, most of them being derived by extensive modifications as a result of ancient glacial outwash and more recent modifications from lacustrine and aeolian deposition. The Chernozem prairie soils of the Palouse were originally very deep and fertile. The grey-brown earths of the westward part of the plateau are generally light and frequently droughty and shallow.

The Big Bend-Palouse-Lower Snake area contains 5.8 percent of

the total land in the Columbia River Basin and 27 percent of the cropland. At present approximately 80 percent of the wheat and half of the dry field peas grown in the entire Columbia River Basin are produced in this area. While only about 130,000 acres are now irrigated, the Columbia Basin Irrigation Project will add in the course of the next few years an additional half million irrigated acres. In addition, a potential of at least another half million acres is available for irrigation development from this project.

The Big Bend-Palouse-Lower Snake area is an important agricultural area of the Columbia Basin. It has been for almost a century one of the outstanding wheat producing areas of the United States. With the installation of Grand Coulee Dam and development of the Columbia Basin Irrigation Project, capable of providing water for irrigation on more than a million acres formerly in range and small grains, this area will be one of the more important irrigated areas of the nation.

Exclusive of the Columbia Basin Irrigation Project, there are 59,800 acres already under irrigation. This acreage is being substantially increased annually on an individual farm basis, through the development of ground water, small storage reservoirs, and stream diversions.

Presently irrigated areas produce primarily alfalfa, small grains, potatoes, sugarbeets and pasture. In some areas, such as in the vicinity of the town of Walla Walla, orchard and truck crops are grown.

To illustrate the basic agricultural pattern in this area, of the 4,982,000 acres of cropland, 4,684,000 acres are presently in wheat and fallow; 164,000 acres in dry field peas; 44,000 acres in alfalfa, and the remainder in irrigated diversified and specialty crops.

There are about 631,000 acres in public range use and about 3-1/2 million acres in private range use.

Forests occupy a minor fringe area along the north and northeastern and southeastern boundaries of the area. About half of all forest lands of commercial importance are in public ownership. They occupy a strategic position and are of great importance as watershed areas affecting the availability and dependability of water supplies for irrigation, domestic and municipal use for the eastern third of the watershed.

The acceleration of urban and industrial development of the Pacific Northwest will result in greater local demand for food products of all kinds. This demand will increase pressure for greater intensification of agriculture in the area.

Conservation problems and programs are of great importance on the vast areas of rolling and undulating dry lands used for the production of small grains. The present irrigated areas, exclusive of the Columbia Basin project now being developed, lie primarily along stream bottoms and alluvial benches; problems are primarily those of drainage, improved irrigation methods and practices, fertility maintenance and weed control. There are many problems associated with the development of the Columbia Basin Project lands.

The Columbia Basin Irrigation Project includes lands of the upland desert plains type. The majority of it is undulating or gently rolling. It is either in native bunch grasses and sage or is being used in a wheat-fallow rotation. The soils, unlike the existing irrigated lands of deep bottom or bench soils, are low in organic matter and nitrogen, and are generally of a loamy texture. They often have moderate to severe restrictions in use because of subsoil hardpans, shallowness, or slope. Areas being converted from native range to cropland are particularly susceptible to severe wind erosion when the native cover is removed. On the rougher sites and those having shallow soils irrigation is practical only by use of sprinkler systems.

In the Columbia Basin Project application of nearly all conservation measures commonly applied to irrigated land are necessary for developing, conditioning the land, and maintaining it for productive use. The installation of these practices is frequently hampered by the lack of available long-term credit for development, adequate technical, on the ground, assistance, and a lack of basic information obtainable by research and investigations applicable to local conditions.

The dry lands of the remainder of the area, broken from native grass fifty to seventy years ago, have suffered generally from a reduction in organic content and a lowering of the fertility level as a result of misuse because of adequate technical knowledge and educational services and production pressure of two world wars. These lands vary greatly in production, primarily as a result of

precipitation differences. From the foothills of the Blue Mountains on the eastern fringe of the area, receiving more than 40 inches of annual precipitation, the lands extend westward to the flat plains adjoining the Columbia River having only about 8 inches of precipitation.

The eastern third of the area, commonly known as the "Palouse", consists of steeply to gently undulating dune-like hills of fertile Chernozem prairie soils and receives precipitation varying from 16 to 40 inches annually. Very little precipitation falls during the growing season, but rain and snow melt is stored in the deep, generally permeable soils. Fall, winter and spring rains, sometimes on frozen soil, cause severe erosion unless the land is properly protected.

The croplands of this part of the area were formerly used almost exclusively in a wheat-fallow system of farming but are being converted rapidly to an annual cropping system. In addition to erosion and fertility problems, many acres of bottom lands interspersed among the rolling hills need additional drainage for maximum production. While it is a natural forage producing area, livestock operations are largely undeveloped. Rather extensive areas of bunchgrass range lands occupy the breaks of the larger streams and some glacial outwash prairies. Much of this range is not over-utilized and is in good to excellent condition.

Steep slopes and eroded hilltops should be converted to woodland or grass-legume crops. The remaining area comprising approximately 90 percent of the cultivated acreage requires grass-legume

rotations, crop residue utilization, and other conservation practices including contour tillage and planting operations.

The southwestern part of the area, adjoining the Snake River and along the Columbia River to Moses Coulee, comprises about 20 percent of the total area. It lies in a precipitation belt varying from 12 inches in the Frenchmen Hills to 6 inches in the Pasco Slope west of Eltopia.

Within this belt lie most of the lands under development in the Columbia Basin Irrigation Project. The land cover is predominantly grass and sagebrush. Wheat is grown in the wheat-fallow system in various parts of the area where suitable soil and moisture conditions exist. Much of the area where wheat is grown is subject to wind erosion. Wind erosion is an extremely severe temporary problem when the range lands are broken up for irrigation developmeht.

The schedule of the Bureau of Reclamation for providing water to these lands includes about 70,000 acres annually for about five years beginning in the 1952 crop year. The Pasco pumping project, part of the Columbia Basin Irrigation Project, became operative in 1949. The first irrigation water provided by the pumps at Coulee Dam was delivered through the canal system for crops in 1952.

The central and northwestern part of the area is primarily a wheat-fallow area into which annual cropping is being extended westward from the adjacent Palouse area. The use of nitrogen fertilizer is becoming widespread in this area. Wind and water erosion are both severe. Most conservation measures are planned for erosion

control against water, the principal cause of erosion. Wind erosion also occurs, and is the major contributing cause of erosion in scattered areas of particularly light soil. Several thousand acres of land have been under irrigation in this area for 50 years or more. These lands consist of scattered small areas either along streams or where ground water is available economically.

AGRICULTURAL HISTORY

The Big Bend-Palouse-Lower Snake area was settled approximately 100 years ago. In its native state it was characterized by the grass-covered rolling hills and broad prairies of the Palouse-Walla Walla areas and of the "Big Bend" area of the Columbia River. Agricultural development proceeded at a slow pace until shortly before the turn of the century. Between 1890 and 1920 there was a great expansion of cropland from the virgin grasslands. Wheat became the dominant crop. This area now is the principal wheat producing area of the West. Yields of wheat per acre, particularly in the more humid sections of the Palouse and Walla Walla areas, are consistently among the highest in the nation.

Much of the wheat produced in this area has been exported to the Orient and the Middle East, making a significant percentage of the total wheat exports of the nation.

Development in the Area

The most significant development which has occurred in this area has been building of the Grand Coulee Dam and Columbia Basin irrigation project by the Bureau of Reclamation, U. S. Department of the Interior. The irrigation features of the Columbia Basin

Project are under construction. The project as originally contemplated would have provided irrigation water for about 1,220,000 acres of arid land in the western part of the Big Bend-Lower Snake area. This acreage has subsequently been reduced by exclusion of areas required by the atomic energy plant, and by withdrawals by land owners. Approximately 518,000 acres are to receive irrigation water in the near future. Irrigation water is being made available to blocks of the project lands each year. It is contemplated that the irrigation facilities for the entire irrigable acreage will be completed within the 20-year installation period of the agricultural program.

Grand Coulee Dam, the largest hydroelectric power project in the world, has exerted a tremendous influence on the economy of the region. Its inter-tie with other federal and private hydropower plants provides low cost power to the entire Pacific Northwest. The Columbia Basin Project will enable the ultimate irrigation of about one million acres, and will likewise exert a strong economic influence on the Northwest and the nation. The Pacific Northwest, now on an import basis for many agricultural products, could become self-sufficient in a number of products. In others the volume available for export could be increased to a marked degree.

Other federal and state agencies outside the Department of Agriculture have few developments or projects in the area not already discussed. The Corps of Engineers has provided some flood control protective works through several towns; namely, Pullman,

Palouse, Walla Walla and Dayton in Washington, and Milton-Freewater, Oregon. The Corps of Engineers is also constructing Chief Joseph Dam on the Columbia River near the mouth of the Okanogan River. This project is primarily for hydro-electric power development, although Congress has approved the incorporation of irrigation features in the development. Lands to be irrigated from the Chief Joseph project lie largely outside the Big Bend-Palouse-Lower Snake area.

The various agencies within the Department of Agriculture are active in the region. The Soil Conservation Service is providing technical assistance to 29 soil conservation districts which lie wholly or in part within the area. The Forest Service administers that portion of the Umatilla and St. Joe National Forests lying within the boundaries of the area. The Agricultural Stabilization and Conservation Program is making direct aid payments to land owners and operators in each county for establishing certain conservation practices and measures. The FHA has declared the Columbia Basin project area a special assistance area and provides farm ownership and operating loans to project settlers. The Extension Service, Rural Electrification Administration, Farm Credit Administration and Agricultural Research Administration each have activities and interests in the area.

Growth in Population

The area population has increased 26 percent during the last decade. The increase to date is due primarily to activities associated with the development of the Columbia Basin project. Settlers are rapidly coming into sections where irrigation water is,

or soon will be, available. Industrial development in this area, and the population growth, are largely associated with agricultural development and forest utilization. Urban settlements serve the agricultural population.

Need for Balanced Development of Land and Water Resources

Development of the Columbia Basin project will continue to markedly change the agricultural picture. Lands now used for grazing or wheat-fallow rotation will be converted to an intensive type of agriculture. Likewise, development of the water resources is proceeding at a rapid rate. The increase in population will make further demands on water supplies, both surface and underground.

The type of agriculture proposed for the Columbia Basin project will include a substantial increase in both beef and dairy cattle production. Available range for cattle is fully utilized and additional areal expansion is not possible. This will require better utilization of, and increased production from, available range or development of supplemental pastures in areas now in cropland use, but better suited to grass production.

PURPOSE AND DESCRIPTION OF THE PROGRAM

The program for the Big Bend-Palouse-Lower Snake area provides a means of developing the Department of Agriculture program and correlating with the land programs of other federal and state agencies. Such correlation and integration of programs is particularly important for the conservation, development and use of land and water resources in this area. It is a region of great agricultural

importance undergoing immediate change largely as the result of large federal irrigation projects, public power development, and through individual developments of water resources and changes in cropping systems.

This program will not only provide correlation of recommendations and actions by the agencies within the Department, but will also provide similar correlation and mutual understanding between the various federal, state and local agencies, which should result in more efficient service to land operators and substantial savings to state and federal agencies.

The program for this area of the Columbia River Basin is essentially a three point assault on the agricultural problems of the area. Preservation of existing resources of land and water, development of new resources, and improvement of both by better management and use are the primary functions of the program. It will serve also to coordinate and accelerate the activities of the Department of Agriculture and to balance, supplement and support programs of flood prevention, irrigation and other water uses.

Preservation of existing land and water resources involves the establishment of practices for waterflow retardation and control of wind and water erosion and controlled water disposal. Halting the process of soil deterioration will reduce sediment contributing to stream pollution and reservoir sedimentation. In addition to the conservation benefits achieved, the productive level of the land will be materially increased.

Development of water resources to supplement irrigation supplies, conversion of land to a more profitable use, and drainage

necessitates installation of numerous practices aimed at increasing production by enlarging the productive base. Cooperation with other agencies in the development of new irrigated areas is also involved in this phase of the program.

Acceleration of the research and educational programs are important to the development phase of the Columbia Basin Irrigation Project because of new problems encountered by the people who farm the land. Development of this project will also force an adjustment of livestock operations by the removal of extensive areas from range use.

Wise management or use of land and water resources has the dual goal of protecting the land and increasing production. Farm management practices aimed at this goal include crop rotations, fertilizing, control of insects and disease, fencing, improved irrigation, better livestock distribution, reforestation, fire prevention and crop improvement. The program may be described as the application of reason and knowledge to routine farm problems to the end that the farm, range and forest lands remain permanently and profitably productive.

The following program is presented to serve as a guide in the orderly agricultural development of the area.

PROGRAM SUMMARY

The watershed program for this area is designed to hasten the time when all of the land included will be used to its full capacity without deterioration. Reduction of sediment and increased production are corollary to the primary aim of land resource conservation, resulting from application of the program.

Accomplishment of the program within a recommended 20-year period will require added effort above current programs and will include installation of stabilization measures for small watercourses.

The estimated total installation cost and the average annual operation and maintenance cost of the program herein outlined is shown in Table I-1.

Table I-1 - Estimated cost of installing and maintaining the recommended program

Type of measure	Installation cost	Annual operation & maintenance cost
	dollars	dollars
Cropland measures	133,047,700	6,411,600
Rangeland measures	15,054,600	691,200
Forest land measures	3,060,200	99,200
Measures not associated with one land use	5,600,000	356,000
Flood prevention measures	6,410,000	104,400
Administrative and management measures	9,897,700	86,300
Technical services	8,261,600	--
Total	181,331,800	7,448,700

Principal benefits to be derived from the program are increased agricultural production and better use of land and water resources. Additional benefits will be reduction of flood damage due to overflow and sedimentation.

Benefit-cost ratios were calculated for those measures judged effective for the prevention of floodwater and sediment damage. The

economic analysis was based on the assumption that an effective land program will be carried out. It is estimated that the average annual floodwater and sediment damages will be reduced by 18 percent, or by $332,000 as a result of these measures.

As a result of the land treatment program, the production of all crops will be increased by 40 percent, range production will increase 70 percent and forest production 50 percent. The average annual value of this increase will be approximately 40 million dollars. Of this increase $437,000 is the result of removing the flood threat from bottom lands of the area.

CHAPTER II

AREA CHARACTERISTICS

C O N T E N T S

TABLES

FIGURES

CHAPTER 2

AREA CHARACTERISTICS

LOCATION AND SIZE

The Big Bend-Palouse-Lower Snake area of the Columbia River Basin is located mainly in southeastern Washington. It includes small segments of northwestern Idaho and northeastern Oregon. It has a roughly circular shape, the diameter being about 160 miles. It includes three major wheat producing sections, known locally as the Palouse, Big Bend and Walla Walla areas. The area contains about 15,664 square miles or 10,025,000 acres.

The area is bounded on the north by Lake Roosevelt (a lake created by Grand Coulee Dam), on the west by the Columbia River, and on the south and east by the Blue and Moscow Mountains. The major streams draining the area are the Palouse, Walla Walla and Tucannon Rivers, Crab Creek and Moses and Grand Coulees. The Snake River enters the area at Lewiston, Idaho and flows westward across the southern portion until it joins the Columbia River near Pasco, Washington. (Figure 1)

Land ownership and use classification is shown in Table II-1.

PHYSICAL AND BIOLOGICAL CONDITIONS

Physiography

In physiographical features the Big Bend-Palouse-Lower Snake area is largely a plateau bounded on the north and western two-thirds by rivers and on the southeastern third by the Moscow Mountains of Idaho and the Blue Mountains of Washington and Oregon. Elevations above sea level vary from about 380 feet at the mouth

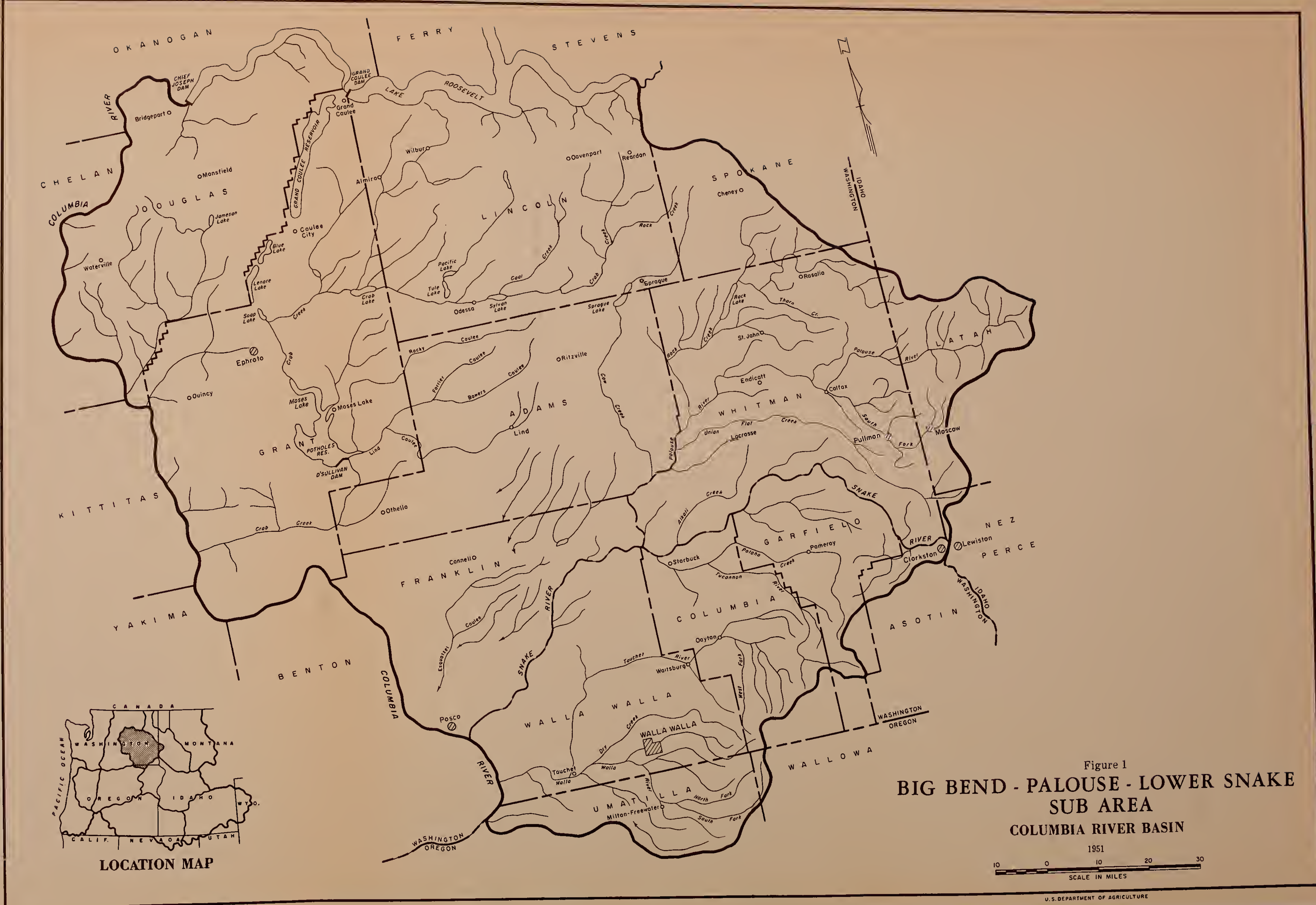

Figure 1

BIG BEND - PALOUSE - LOWER SNAKE SUB AREA

COLUMBIA RIVER BASIN

1951

Table II-1.—Land ownership and classification

Land Ownership	Forest	Nonforested range	Cropland: Irrigated	Cropland: Nonirrigated	All Other	Total
Federal						
Dept. of Agriculture						
Forest Service	271,975	19,211			7,763	298,949
Soil Cons. Service				161		161
Other						
Total	271,975	19,211		161	7,763	299,110
Dept. of Interior						
Bur. of Land Mgmt.	2,960	73,269			2,235	78,464
Natl.Parks & Monuments		46				46
Indian Reservations						
Bur. of Reclamation		79,710	4,000	161,300	12,116	257,126
Fish & Wildlife		15,048			20	15,068
Total	2,960	168,073	4,000	161,300	14,371	350,704
Other Federal		89,400			2,760	92,160
Total Federal	274,935	276,684	4,000	161,461	24,894	741,974
Local Government						
State	31,418	354,749		86,320	9,525	482,012
County						
Municipal						
Total Local	31,418	354,749		86,320	9,525	482,012
Private						
Total Private*	275,740	3,598,590	55,804	4,674,558	196,489	8,801,181
Net land total	582,093	4,230,023	59,804	4,922,339	230,908	10,025,167
Water surface total						74,240
Grand total						10,099,407

* Includes County and Municipal lands not under specific management.

of the Walla Walla River in the southwestern part to some 6500 feet at the Oregon Buttes in the Blue Mountains fringe on the east. The drainage pattern of all the area except the extreme northern edge is toward the southwest into the Snake and Columbia Rivers. In general this area might be visualized as a broad basaltic plateau overlaid by loessial type soils and dissected by ancient stream beds cut by glacial waters to form Moses Coulee, Grand Coulee and the channelled scablands. A plucking rather than an abrading type of geologic erosion through the basalt has left island mesas and cliff-sided coulees. The largest of these is the Grand Coulee wherein 10 cubic miles of basalt are estimated to have been plucked out, resulting in a coulee 30 miles long with vertical cliff-like side walls. The retreating glacier left huge boulders, locally called "haystack rocks", on farm fields in Douglas County, and mounded moraines in lower Spokane County. Winds, predominantly from the southwest, have left a streaked, wind-blown, soil pattern in western Walla Walla County, steep sided hills to the north and the cone pocketed dune-like topography of the Palouse hills. A similar wind pattern influences the sand dunes of central Franklin County and the black sands and "potholes" south of Moses Lake in Grant County. The local names of "Michigan Prairie" and "Rattlesnake Flat" in central Adams County are descriptive of the gentle slopes of much of the drier wheat land areas.

The cultivated lands of the Big Bend-Palouse-Lower Snake area are divided into (1) the irrigated river bottoms and narrow flood

plains under 1000 feet in elevation which frequently have precipitation too low for crop production; (2) the dry wheat land area which extends from 800 to 2000 feet in elevation with precipitation from 8 to 15 inches and where alternating summer fallow and wheat is the predominant cropping system; and (3) the more humid annual crop area, from 1700 to 3000 feet in elevation, which receives precipitation of 15 to 30 inches, making it possible to substitute legumes and nitrogen fertilizer for summer fallow in crop rotations and produce some of the highest field yields of wheat in the nation. Figure 2 illustrates the major land forms of the area.

Soils and Geology

Geologic Features

The bedrock of the Big Bend-Palouse-Lower Snake area is basalt. This vast expanse of Columbia River basalt is the result of a series of lava flows which attain a maximum thickness of 5000 feet. However, along the northeastern and northwestern boundaries, bodies of granitic, metamorphic and sedimentary rocks, ranging from Pre-Cambrian to lower Tertiary age, occur in a belt overlapped by the lava flows. The area is part of a larger structural basin which has been modified by deformation, erosion and deposition. The mantle of sediments overlying bedrock is the result of deposition of glacial outwash, loess, lacustrine sediments, alluvium and recent aeolian deposits. This mantle is considered to have an average depth of 50 feet but ranges from a few feet to more than 150 feet in depth. In places alluvial and outwash

LOCATION MAP

Figure 2

LAND FORMS

BIG BEND - PALOUSE - LOWER SNAKE SUB AREA

COLUMBIA RIVER BASIN

1951

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U.S DEPARTMENT OF AGRICULTURE

gravels furnish moderate to large supplies of water to wells. Where the topography and structure is favorable, such as in the lower Palouse River drainage, large supplies of ground water sufficient for irrigation use is available from aquifers in the lava beds. Figure 3 indicates the soil parent materials of this area.

Soil Characteristics

Glaciation and deposition occurring since Miocene time accounts for the glacial drift, alluvial, lacustrine and aeolian deposits which now cover much of the Big Bend-Palouse-Lower Snake area. The influence of volcanic ash windborn from the southwest has had a pronounced effect on soil textures over the region, often masking underlying features. The soils vary in texture, depth and subsoil characteristics depending upon their origin and aeolian cover. The deeper profiles extensively associated with the continental sediments which are largely of loessial origin are found in all parts of the basin, the largest area being in the central and eastern sections.

The western part shows a gradual thinning toward the shallow, light to coarse textured soil profiles. The channelled scablands and broad outwash channels are characterized by a very thin mantle of light to coarse textured soils with exposed areas of lava bed-rock. Younger alluvial soils of variable depth and texture usually occur as narrow strips along stream channels.

Climate

The climate of the area is, in general, temperate and largely

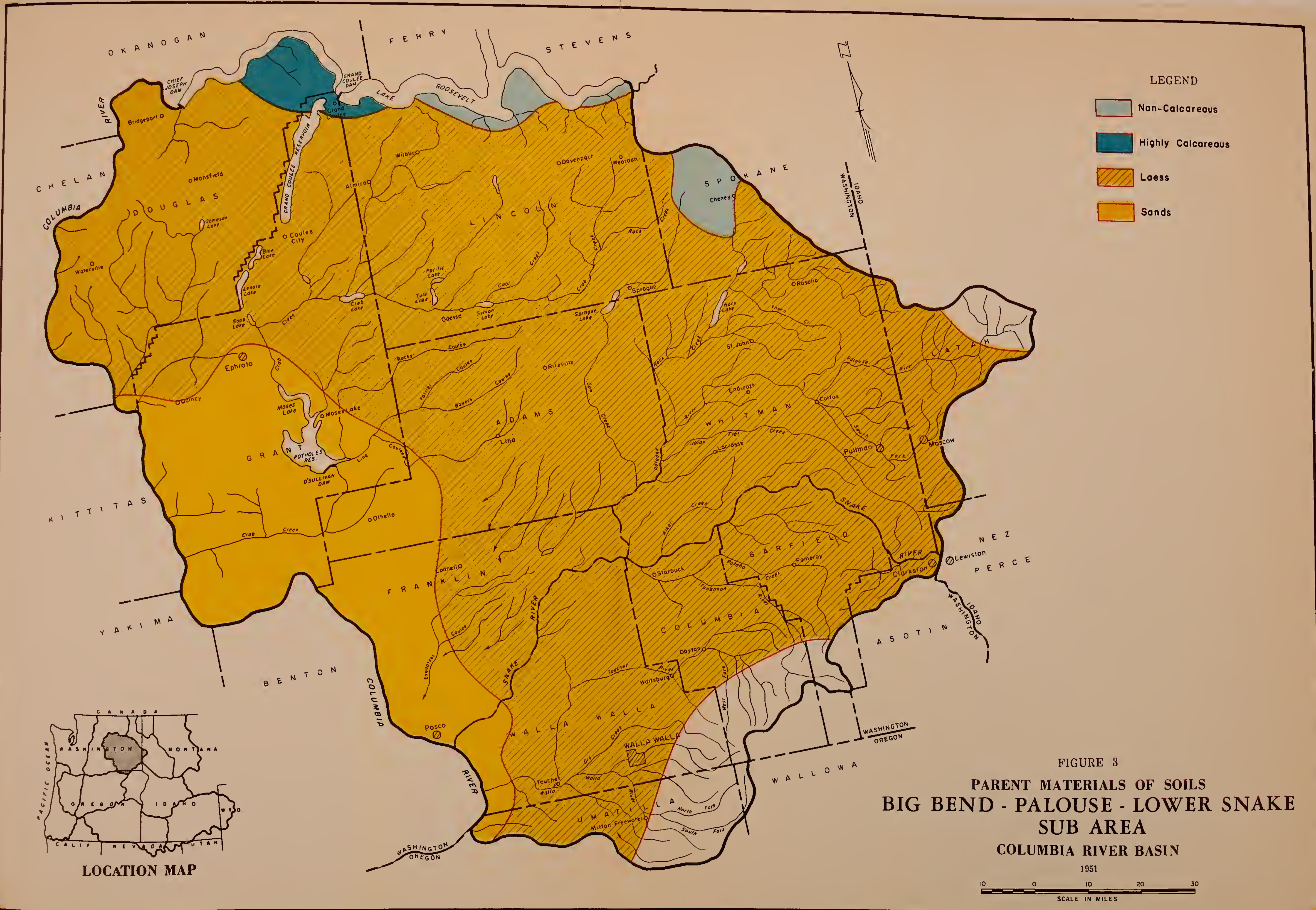

FIGURE 3

PARENT MATERIALS OF SOILS

BIG BEND - PALOUSE - LOWER SNAKE SUB AREA

COLUMBIA RIVER BASIN

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semiarid, although great differences in rainfall occur between the higher and lower elevations. Seasonal distribution of rainfall likewise varies, with a winter wet season and a summer dry season. A semicontinental climate, characterized by wide temperature extremes, is predominant but is tempered somewhat by the mild westerly air currents from the Pacific Ocean. The relative humidity is low and there is an abundance of clear days.

Precipitation

Most of the precipitation in the area results from the eastward drift of cyclonic storms originating in the Pacific Ocean in the vicinity of the Aleutian Islands and passing inland along the Oregon-Washington coast. There is a semipermanent anti-cyclonic high pressure area over the Pacific Ocean in the vicinity of the Hawaiian Islands. In the fall of the year this high pressure area drifts southward, permitting the cyclonic disturbances mentioned above to drift south and eastward, and to reach this area. In the spring of the year, the high pressure area drifts northward, shutting off the cyclonic storms. The topography of the area, however, is a factor which modifies the effect of these cyclonic disturbances. Storms from the Pacific Ocean rise to pass over the Cascade Mountains and in doing so lose moisture. In descending from the mountains into the Big Bend of the Columbia, the air becomes relatively drier. Consequently, over central Washington there is a preponderance of dry air and clear sky with scant precipitation of both rain and snow. East of the Columbia River there is a gradual increase in precipitation as air again rises to pass over the mountains to the east and is cooled in doing so.

The average annual precipitation varies from 6 inches near Pasco, Washington, to over 50 inches on the headwaters of the Walla Walla River in Oregon, and is more than 28 inches on the headwaters of the Palouse River in Idaho. Approximately 70 percent of the annual precipitation falls during the 6-month period October through March, much of it in the form of snow. Average annual snowfall at Ephrata is 17 inches. Average snow depth on April 1, at Tollgate snow survey course at the head of the Walla Walla River, is 68 inches. Extremes in 21 years of record at this snow course were 0 inches and 111 inches measured about April 1.

Snow storage is important as a source of irrigation water and in its potential as a flood hazard. In low areas snowfall remains on the ground only intermittently, but at higher elevations it accumulates during the winter months. Snow survey measurements show the average water content of the snow to be 27.4 inches on April 1 at the Tollgate snow course. The Sherwin, Idaho course, representative of the conditions on the headwaters of the Palouse, has an average snow depth of 34.6 inches on March 1, with an average water content of 11.2 inches.

Melting of the snowpack usually begins in March or April and continues through June at higher elevations. The rate of melt depends largely upon the prevailing temperatures and wind movement. The critical runoff period is from the middle of February through the last of May when rainstorms may coincide with rapid snowmelt.

The greatest amount of precipitation occurs in the fall, winter and spring months when warm moist air from the ocean moves

inland. These storms are large in areal coverage and seldom exceed intensities of 1 inch in 24 hours. These disturbances frequently last for several days and when extended rains fall on saturated soils or on soils that are frozen beneath the surface, extensive erosion damages and moderately high stream flows occur. Summer precipitation results from storms characterized by heavy showers and occasional cloudbursts. These summer storms are unpredictable as to frequency, but their occurrence often results in considerable local damage to fields, crops and property.

The occurrence of droughts is mostly limited to the marginal areas of the wheat producing belt. Much of the region in the Big Bend of the Columbia is too arid for dry-farm operations. Occasionally in dry years there is a shortage of irrigation water as a result of inadequate snow storage in the mountains.

An isohyetal map indicating the average annual precipitation throughout the area is included on Figure 4. This map was compiled from maps prepared by the Corps of Engineers. July and August are the months of lowest precipitation and December and January are the months of maximum precipitation, much of it falling as snow. At high altitudes practically all winter precipitation occurs as snow. A secondary peak usually occurs in May or June and comes as rain, except at high elevations.

Temperature

Mean annual recorded temperatures vary from a minimum of 46.3° at Potlatch, Idaho, to 53.1° at Walla Walla, Washington. Extreme recorded temperatures vary from a high of 118° at

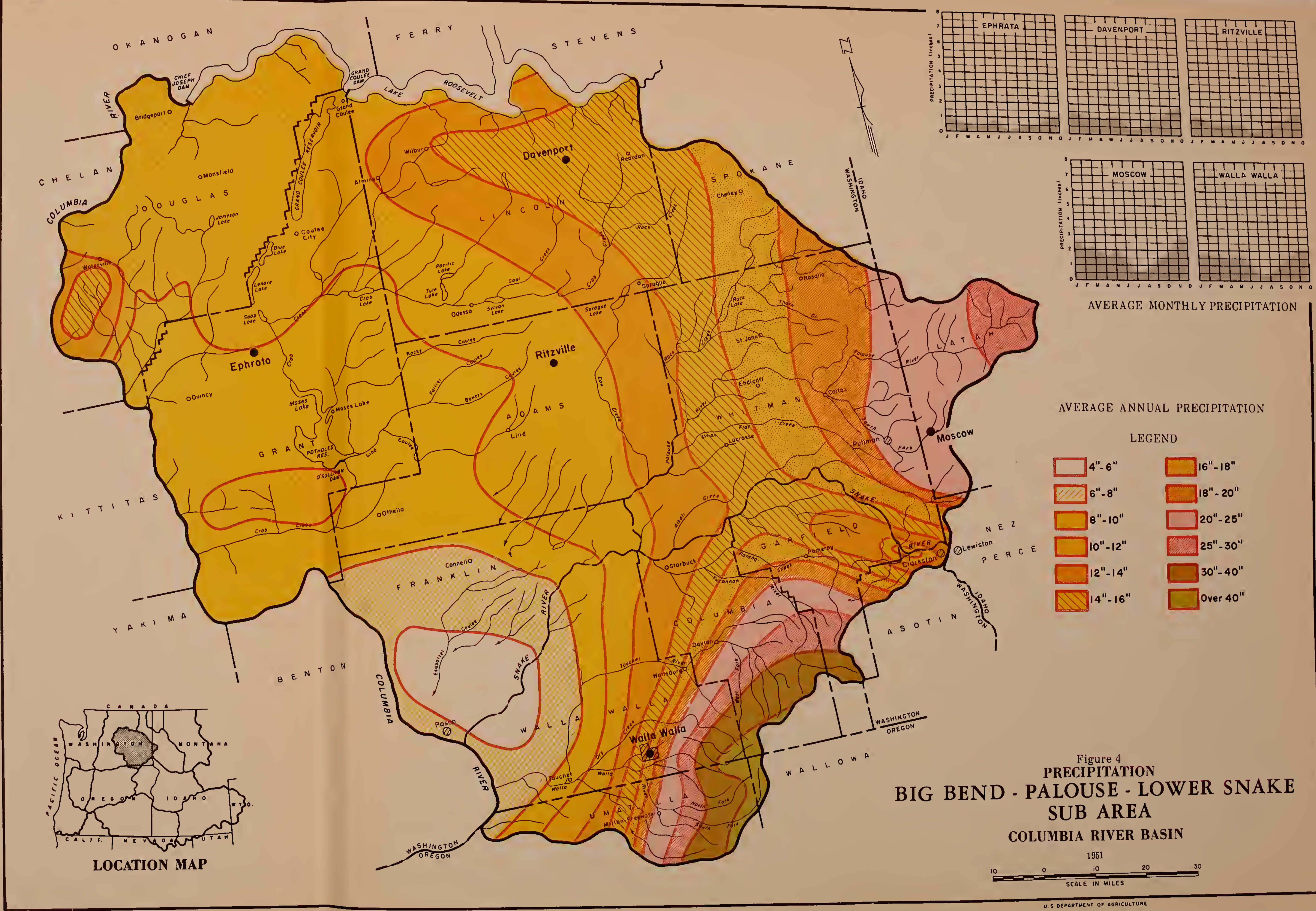

Figure 4
PRECIPITATION
BIG BEND - PALOUSE - LOWER SNAKE SUB AREA
COLUMBIA RIVER BASIN
1951

Wahluke to a low of -36° at Potlatch. No temperature data are available for mountainous areas, but indications are that temperatures are considerably lower at altitudes higher than the weather stations.

Extremely high and low temperatures in the area are commonly of short duration. "Hot spells" in the summer generally last only a few days. Prevailing summer temperatures are relatively mild. Extremely low winter temperatures likewise are generally of short duration. They are associated with rather infrequent invasions of cold air masses from Canada. In general, winter temperatures are not severe. The length of the frost-free growing season varies from 219 days at Walla Walla to 99 days at Wilbur, Washington and Potlatch, Idaho. Shorter growing seasons probably occur at higher altitudes where there are no weather records.

Favorable night-time temperatures are important in the production of specialized crops in the Walla Walla area. Fruits and vegetables grown there are highly vulnerable to frosts.

A map showing isopleths for length of average frost-free growing season is included on Figure 5. This figure also includes charts of seasonal distribution of average temperature by months for selected stations.

Wind, Evaporation and Transpiration

The average wind movement over the area is at low velocity, being the highest in the months of March, April, May and June. Dust storms are common during these months in areas of lighter textured soils. Maximum wind velocities reach 50 miles per hour

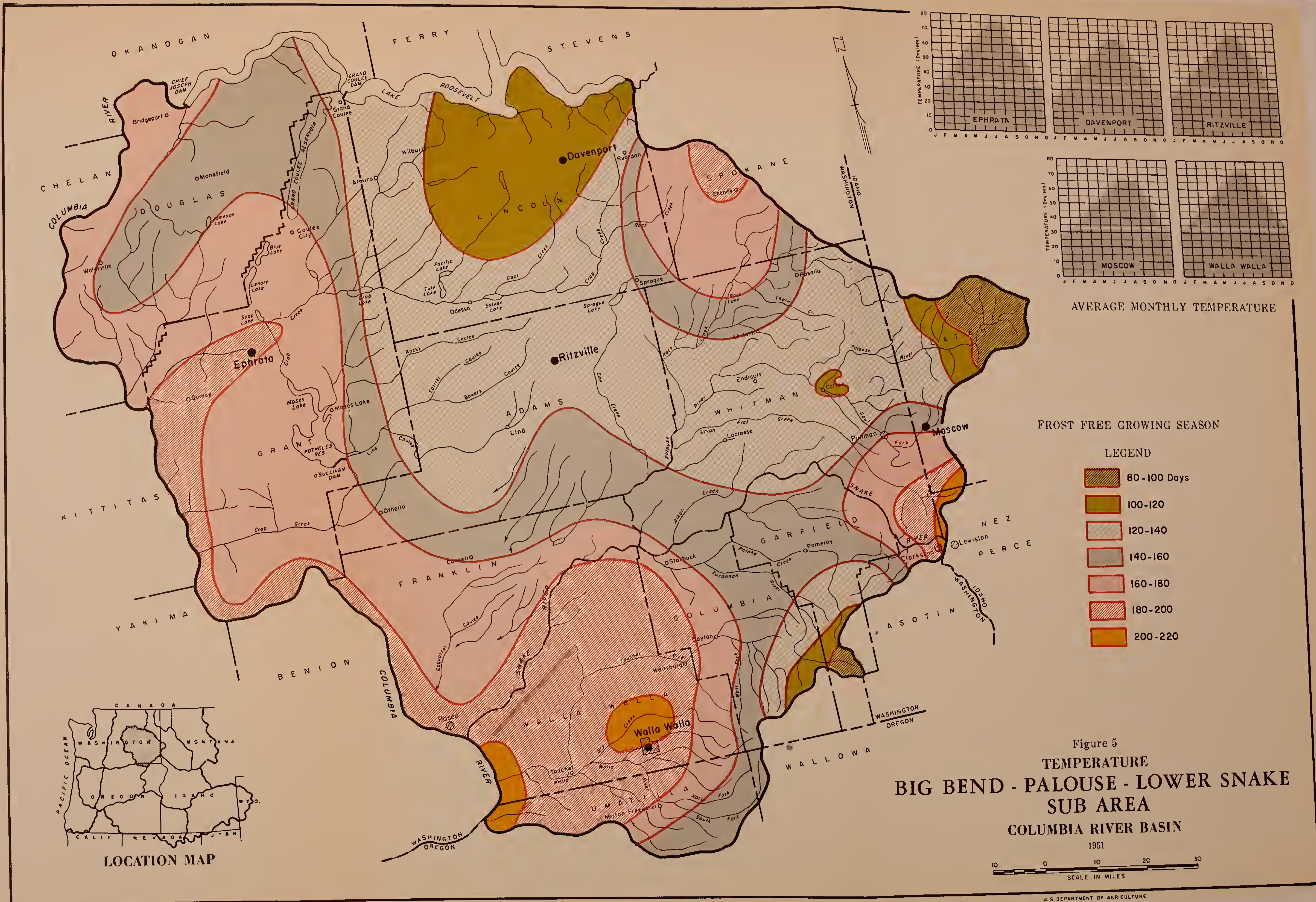

Figure 5
TEMPERATURE
BIG BEND - PALOUSE - LOWER SNAKE SUB AREA
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during these storms. Local topography has slight effect in determining the direction and force of surface winds, for most of the weather stations show a prevailing direction for the year from the southwest. The average annual velocity at Walla Walla is 5.6 miles per hour. Chinook winds, which are warm air currents, may occur at any season of the year, but the effects are most marked in winter when they may cause a temperature rise of 20 to 30°F in fifteen minutes.

There is considerable variation of wind movement in the area. Observations indicate that, generally, those parts of the area situated near the Columbia and Snake River gorges have stronger winds over longer periods of time than the sections more remote from the gorges. No records are available to indicate the quantitative differences that exist.

Evaporation is comparatively great during the summer owing to the very low humidities, the large amount of sunshine, and the periods of high temperature. The average rates of evaporation for certain months of the year, determined by evaporation pans are shown in Table II-2.

Transpiration rates of crops and other vegetation, greatest during the hot summer months, are moderate during the spring and fall months, and are negligible in the winter months when the plants are dormant. Consumptive use of water (evaporation and transporation) for some irrigated crops in the hottest part of the area is more than 30 inches for the growing season.

Table II-2.--Evaporation from free water surface for various stations in the Big Bend-Palouse-Lower Snake Area

Station & Location	April	May	June	July	Aug.	Sept.	Oct.
				INCHES			
Walla Walla, Wn.	4.30	6.18	7.58	10.54	9.16	5.27	2.55
Lind, Washington	4.75	7.06	7.86	10.80	9.57	5.84	-
Othello, Wn.	5.53	7.55	9.00	12.61	10.60	6.88	3.20
Qunicy, Washington	5.91	8.49	9.90	13.68	11.48	7.42	3.54
Moscow, Idaho	3.08	4.20	5.23	7.74	6.11	3.43	-

Surface Water Resources

Water, as it occurs in the form of precipitation or stream flow, is one of the most valuable renewable resources of this area, and the economy depends heavily upon its use. One of its major uses is for irrigation, the full development of which is yet to be realized. On completion of the Columbia Basin Irrigation Project there will be over one million additional irrigated acres in production in this area. In order to obtain the additional water supplies needed for supplemental irrigation of lands now partially irrigated, and to obtain water to irrigate new lands, additional storage reservoirs are needed.

The development of water resources for power is vital to the future development of the area. Low-cost hydroelectric power has been a boon to the electrification of farms and homes and is essential to industrial growth. Virtually all of the electricity produced in the region is generated by water power. A great potential development of hydroelectric power still remain for the future.

Other important uses of surface water resources are for domestic water supplies and industrial uses.

Average annual runoff varies from a maximum of about 35 inches at the head of the Walla Walla River to less than one inch in the western portion of the "Big Bend" of the Columbia River. The occurrence of annual runoff is, in general, closely correlated with amount of annual rainfall. Local differences are due to such factors as evaporation, transpiration and geology. These factors might be additive or compensating in their effect on water yields, depending upon existing conditions.

Figure 6 shows the normal distribution of runoff by months at selected gaging stations in the area. An important feature of the runoff, illustrated by the map, is that flow is greatest in the spring and early summer and that high flows usually prevail for fewer months than low flows. The high water period is primarily associated with the melting of the accumulated mountain snow which reaches its climax with the onset of the warm season. There are local variations in the time of occurrence of high water because of differences in altitude. The most marked seasonal concentration is noted on Missouri Flat Creek near Pullman, Washington, where nearly 50 percent of the annual runoff occurs in March. This creek is an example of a watershed composed mainly of agricultural land.

The trend of annual flows of the Columbia River since 1895 has been distinctly downward. The general trend of the streams tributary to the Columbia closely parallels that of the main

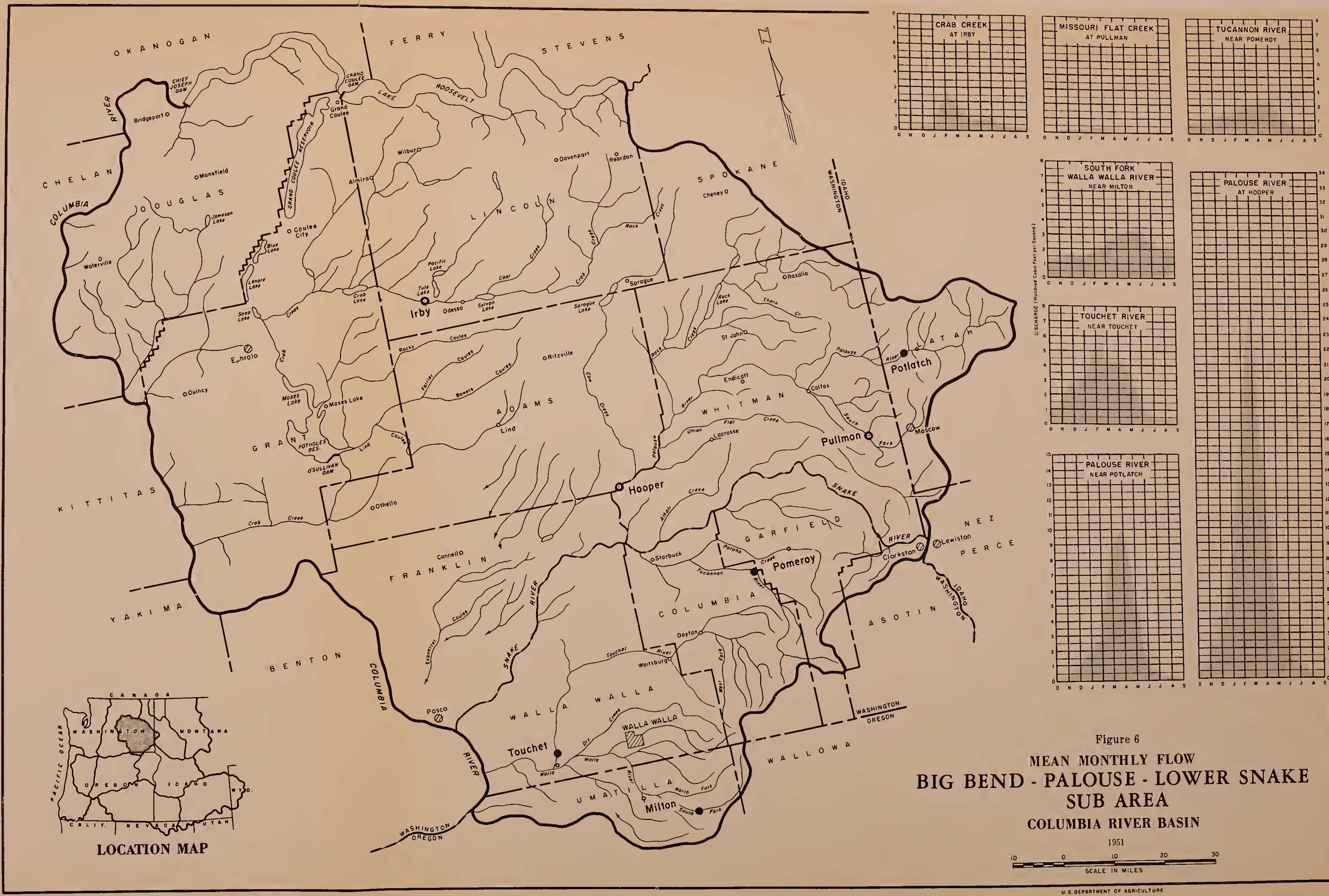

Figure 6

MEAN MONTHLY FLOW

BIG BEND - PALOUSE - LOWER SNAKE SUB AREA

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river. This trend in river flow is not likely to persist indefinitely, but just when and in what manner changes will occur cannot be foretold. The available stream flow records for the area are of comparatively short duration and are of recent origin. In view of the long-time runoff trend it is probable that, if longer stream flow records were available, higher average annual flows and flood peaks would be indicated.

The mountainous areas of the headwaters of the major streams are the main contributors to runoff. Forest vegetation is typical of the cover on these high watershed areas. This type of vegetation is known to reduce the potential of flood peaks by retarding runoff. At the same time, the watershed yield is less than that of a nonforested area with the same geology and climate. Forest cover transpires quantities of water and the trees intercept snowfall, much of which evaporates into the atmosphere before reaching the ground.

The forested watersheds give a sustained yield of runoff that may extend over a period of several months. Streams from forested areas are very important to the lands that depend upon one or two early irrigations for the entire year's supply of irrigation water.

Runoff from agricultural and range lands as contrasted to forested area is usually more rapid and earlier in the season. Therefore, surface runoff from these sources contributes less to agriculture or to industry unless reservoirs are constructed to hold the runoff for use later in the season.

The streams of this area that originate at higher elevations, are unusually regular in their annual high water cycle. The high water period each year occurs in the spring or early summer and is due principally to snow melt at high altitudes.

This characteristic of the distribution of runoff is not compatible with general irrigation needs, as the season of heavy irrigation demand comes at a time when rate of runoff is approaching a minimum. Full utilization of the water resource necessitates storage during the high water flows for later release to meet the demands of growing crops.

Although some use is made of peak flows in late spring for agricultural and municipal purposes, the great majority of such runoff flows down the rivers without being put to any beneficial use.

Ground Water Resources

Ground water resources of the Columbia Plateau are rather limited. The total potential supply is far less than the total future water needs of the area. Also, explorations for ground water in the area have been rather limited. The small amount of investigational work done, however, indicates that there are four ground water provinces of significance in the area.

(1) Columbia basalt. This area is underlain by the Columbia basaltic flows. They are some 2000 feet thick in places, tapering out to nothing in the Blue and Potlatch mountains on the east. The many individual flows making up the total are massive and impervious except for extensive cracking caused by contraction during

cooling, making the otherwise impervious material so jointed that percolating water has relatively open avenues of passage downward. Also, as the basalt flowed out over the area in successive layers, the planes of contact were broken and became scoriaceous, affording storage capacity and planes of lateral flow for ground water.

The Columbia, Snake, Palouse, Walla Walla and Umatilla rivers and many creeks (notably Crab Creek) cut gorges into the basalt that are hundreds of feet deep. This master drainage system effectively drained the upper basalt beds, in most places leaving the ground water table far below the surface, approaching the level of the rivers themselves. Ground water in these basaltic basement rocks probably underlies most of the area. Except where this ground-water basin is supplied by stream flow from the mountains recharge is limited by the low precipitation over the area. Because of this limited recharge, the total safe yields of this aquifer are likely to be limited. Also, this ground-water basin is hundreds of feet below the ground surface in most places, hence large developments are likely to be limited by the high costs of wells and pumping.

(2) Walla Walla River-Mill Creek. The flood plain of Walla Walla River and Mill Creek in the vicinity of Milton-Freewater, Oregon and Walla Walla, Washington is composed of recent alluvium many feet deep. This outwash material from the Blue Mountains contains water, some artesian, in large quantities. The ground-water basin has been rather fully developed for irrigation of truck, fruit and field crops. It is doubtful if much more water can be developed here without overdrawing the available supply.

(3) Moscow Mountain Slopes. Extending westward from the Palouse divide to and probably beyond Pullman, Washington is an artesian aquifer. This is the source of municipal water supplies for Moscow, Idaho and Pullman, Washington. The pressure in the aquifer declined steadily for many years until 1948, when it recovered slightly. It appears, therefore, that the potentials of this aquifer for further water supplies are limited.

(4) An aquifer similar in many respects to that in the vicinity of Pullman and Moscow exists northward from the Blue Mountains in Garfield and Columbia counties. Ground water in this area is so deep, however, that the high cost of development prevents utilization except in a few narrow valleys lying below the general land level of the area.

(5) Other minor ground-water bodies exist in this area but they are small in extent and yield. These include the Touchet River Valley, small areas in Crab Creek and Moses Coulee, and in other narrow valleys. Not enough exploratory work has been done to determine the extent and capacities of all of these small aquifers.

Relation of Ground Water to Stream Flow

Ground water is related to stream flow in two important ways: (1) In this area, where precipitation is largely concentrated in the late fall, winter and early spring months, summer stream flow is almost entirely sustained by flow in the form of springs and seeps from the ground water. (2) In some locations, where streams flow across unconfined aquifers, part of the wet season stream flow sinks and recharges the ground-water basin.

In this area the low summer stream flow in all important streams is indicative of the relatively small ground-water basins available for supplying springs. There are no large springs in the entire area. Many of the small springs and seeps are typically "wet weather"; that is, they flow during the wet season and dry up soon after rains cease. In the Blue Mountains, headwaters of the Walla Walla River, a fault striking in a generally northwesterly-southeasterly direction apparently caused several springs to develop that supply the Walla Walla and its major tributaries with dry season flow. In the Moscow Mountains, no comparable springs exist. Crab Creek has a few minor springs and seeps that maintain low summer stream flow. Moses Coulee is dry during the summer.

Crab Creek is likely to have an increase in summer stream flow in the future due to augmentation of the ground water supply by eventual irrigation of about one million acres in the Columbia Basin irrigation project.

Depletion of winter and spring stream flow by percolation to ground water (or soil moisture) is important in this area in only two localities - the Walla Walla River Valley and in parts of the Crab Creek system valleys. In the Walla Walla Valley, the ground-water basin that supplies water to wells to irrigate an important agricultural area is largely recharged by the Walla Walla River and its tributaries. The percolation rate is not high enough to decrease markedly high flood flows, but it does noticeably affect low flows.

In the Crab Creek basin precipitation is generally insufficient to completely fill the soil profile. Farmers and ranchers in the valleys have constructed dikes across the narrow valleys to impound stream flow during the winter and early spring, permitting it to soak the soil profile. This practice has a pronounced effect on flood flows since the flooded areas provide storage capacity to detain flood water. These same dikes also pose a flood threat to lower reaches. Should a series of these break, impounded water could be suddenly released in sufficient quantities to inundate much of the lower lying valleys. The practice, however, is effective in increasing the soil moisture in the deep valley soils, permitting production of alfalfa.

Erosion and Sedimentation

Erosion and sedimentation are two related processes that have reached serious proportions in the Big Bend-Palouse-Lower Snake area. Erosion is particularly severe in the wheat producing area extending from the southern boundary near Walla Walla north to Spokane. During the four years 1948-1952 an average of about 3,000,000 acres in the watershed have lost more than 12 tons of soil per acre per year. Sediment carried off the fields by melting snow and rain is deposited on roads, in road ditches, and on railroads. Sediment also clogs streams, deposits on flood plains and in ponds. Sediment reaching the major streams is largely carried into the Columbia River and deposited behind dams, in the lower reach of the river, or is carried out to sea.

Erosion Areas

The combination of severe climatic conditions and soil that is disturbed by cultivation or intensive grazing without adequate protection gives cause for heavy erosion losses. Severe soil losses in January, February or March are usually preceded by a wet fall that raises the moisture content of the soil to field capacity. A period of cold weather then freezes the surface layer sometimes to depths of 36 inches. Rains and rapid snow melt cannot percolate into the frozen soil. The high runoff then removes any thawed and moisture saturated layer.

The soil losses from conditions described above frequently occur in a few hours or days of runoff. The resulting rills and gullies are obliterated by the next cultivation. In certain areas any one season's runoff may gouge out gullies too large to cross with agricultural equipment. Gullying of this type has so far been restricted to the eastern, humid portion of this area, particularly in the deep loessal soils of Walla Walla and Columbia counties.

Erosion by furrow irrigation, severe in a number of sections of the Columbia River Basin, has been only a minor problem in this area due to the gentle slopes in the irrigated valleys. With the development of the Columbia Basin project, however, extensive erosion has been occurring on the lands first opened to water. Complete land preparation and proper water distribution systems are required to minimize erosion. Measurements have shown that such annual soil losses from irrigation may amount to 20 tons or more per acre.

Bank cutting occurs along streams that head in the Blue Mountains, such as the Walla Walla, Touchet and Tucannon Rivers. Gravel and coarse sand, deposited in bars along the alluvial reaches of the streams, direct the current against the sides of the banks until meander bends are created. Fine sediment deposited on these bars may eventually rebuild the bank eroded area. This does not occur for many years and frequently the rebuilt land is on the opposite side of the stream from its original position. An example is the Touchet River which cuts away about 15 acres of agricultural land per year.

Wind erosion affects the light-textured soils in the low rainfall areas of Grant, Lincoln, Adams, Franklin and western Walla Walla counties. The soil is particularly vulnerable to wind erosion during the summer fallow year. Prevailing winds from the west and southwest occasionally remove the soil to plow depth and pile it in dunes, in drifts along fences, across roads, and into irrigation and drainage ditches. The finer material is blown into the air, creating the disagreeable and frequently hazardous conditions associated with dust storms.

Water erosion is by far the most significant in the eastern portion of the area having 10 inches or more of precipitation. The major water erosion zone extends from along the south boundary near Walla Walla north and east almost to Spokane. Differences both in climate and land use account for a wide range in the degree of erosion even within this zone. Douglas County in the northwestern part of the area is affected by erosion similarly to the east portion.

The two predominant factors affecting the amount of erosion are the degree of soil disturbance and the frequency and severity of storms. In areas where a wheat-summer fallow system is followed, most of the wheat is seeded in the fall, harvested the next summer and the land is left in stubble until the following spring. During the winter season when in wheat, insufficient protection to the fields is afforded by the young grain plants to prevent erosion.

Plowing of foothill slopes of the Blue Mountains is increasing the area of land subject to erosion. Over-grazing by domestic stock and wild game exposes the soil to the forces of wind and water erosion. Trampling compacts the surface and increases the amount of water runoff.

One of the worst erosion seasons of recent times in the Walla Walla area occurred during February of 1949. The climatic events leading up to this period of severe erosion occur with relative frequency in this area as well as in the rest of the Columbia Basin during the winter months. The soils in the area moistened by fall rains were frozen by the middle of December, 1948. January was an unusually cold and dry month and the soils were frozen to increased depths, up to 30 inches. A rainfall of .03 inch was accompanied by a 60 degree temperature on February 10. This took the frost out of the top two to six inches of soil. A total of slightly more than 1 inch of precipitation on February 16, 18 and 19 followed by more rain and warm winds on February 21 and 22 caused runoff and severe erosion between February 21 and 23.

Some fields lost more than 300 tons of soil per acre. An estimated 16,000,000 tons were lost from 343,000 acres in Walla Walla and Columbia counties alone. Conditions similar to those described above existed in Whitman County during the 1950-51 season when a little more than one million acres lost a total of 10,760,000 tons of soil.

Beginning in 1948, estimates have been made of annual erosion losses on all lands in the Columbia Basin. Only those areas losing 5 tons or more per acre have been tabulated. These estimates for the Big Bend-Palouse-Lower Snake Area by runoff seasons are given in Table II-3.

Table II-3.--Erosion loss in the Big Bend-Palouse-Lower Snake Area - 1948-1952

Year	Area	Total Soil Loss	Average Loss
	Acres	Tons	Tons/Acre
1948-49	2,020,970	33,340,000	16.5
1949-50	2,136,400	22,424,000	10.5
1950-51	1,513,720	24,820,000	16.4
1951-52	2,180,174	19,397,000	8.9

In addition to the tabulated losses it is estimated that at least an equal amount of soil is lost from lands losing less than 5 tons of soil per acre per year.

Sedimentation

The first systematic measurements of suspended sediment load in this area were made between 1934 and 1940 on the South Fork of

the Palouse River and four of its tributaries. In recent years similar measurements have been taken on the Walla Walla River and the Touchet River. The measurement of sediment in reservoirs is limited because of the very small number of storage basins in the area. The sediment deposits in one large desilting basin on Wilson Creek, a tributary of Crab Creek, Grant County, Washington were measured in 1936. A number of stock pond sedimentation surveys adjacent to and one within the area were made in 1951.

The available sediment measurements show that sediment production varies from less than 0.1 acre foot per square mile to as much as 7.0 acre feet per square mile. Generalized sediment production is indicated on a map of the area, Figure 7.

Erosion losses that determine the amount of sediment produced are much greater than the sediment load measured at some downstream point. A comparison of sediment production from watersheds as small as 2.3 acres with that from 27 square miles and larger in the Palouse River watershed showed that only about 25 percent of the sediment measured in the smaller watersheds was carried downstream.

The heaviest concentrations of sediment in the area, as determined by limited records, are in the Touchet River, tributary to the Walla Walla River. The maximum concentration of sediment during a year's sampling program amounted to 82,000 parts per million or over 8 percent of the volume of water. Similar measurements on tributaries of the Palouse River indicate that maximum concentrations are between 2 and 3 percent of the water volume. Extremely high concentrations are due largely to

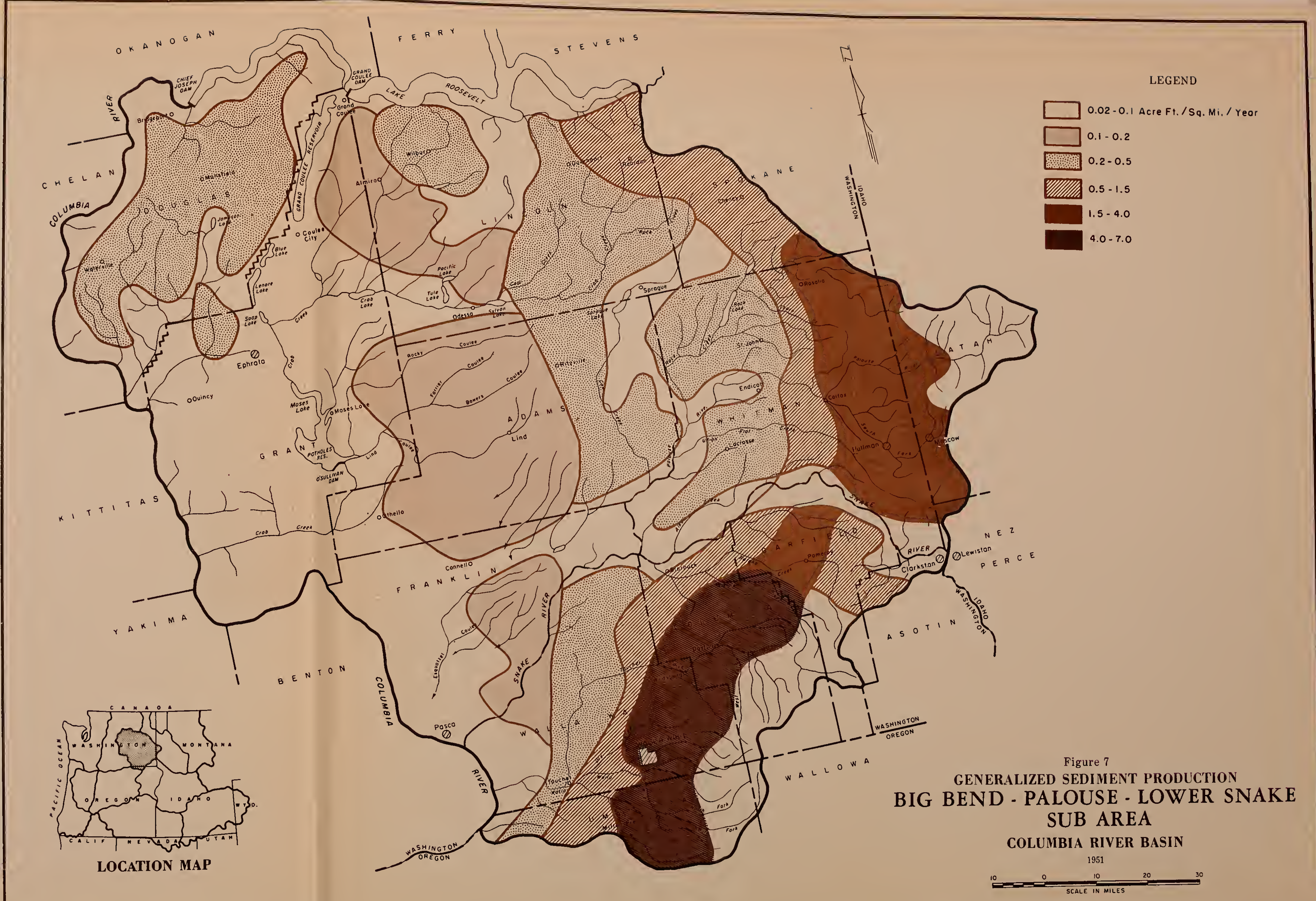

Figure 7
GENERALIZED SEDIMENT PRODUCTION
BIG BEND - PALOUSE - LOWER SNAKE
SUB AREA
COLUMBIA RIVER BASIN
1951

erosion caused by runoff from snow melt and precipitation across cultivated fields when the underlying soil is frozen.

The damages from sediment in the area are very extensive, chiefly because of the great volume transported during winter and spring thaws. Damages occur to crops, roads and railroads, flood plains, channels and ponds. Road damages, by far the most extensive, are caused by sediment being deposited over the roadways and in the ditches and drains. In addition to the hazards and traffic interruptions, the cost of removing the large volume of mud constitutes one of the greatest items of damage in the area. The source of most of this sediment is the cultivated, steeply sloping fields adjacent to the roads.

Channel aggradation is occurring along streams in the Palouse and Walla Walla watersheds. Streams issuing from the Blue Mountains carry coarse sediment such as sand and fine gravel which deposits on bends, causing bank erosion through stream current diversion. Fine sediment clogs small drainageways when they are overgrown with brush, increasing the frequency and area of flooding. There are many small tributaries of this type in the Palouse River watershed.

Flood plain deposition is common along many streams in the zone of high sediment production. The flood plain of Union Flat Creek, tributary to the Palouse River, has deposits of 4 feet and more in depth that extend across the flood plain for several miles along the valley. Most of the deposited soils on Union Flat Creek and other flood plains are suited to intensive crop use if protected and properly managed.

Sediment damages to drainage and irrigation ditches and ponds are relatively minor in this area due to the small quantity of such installations. Wind-borne materials are reducing the capacity of many new ditches in the Columbia Basin Irrigation Project and both this and sediment will have an increasing effect as development continues.

Sediment that is carried into the major streams during flood flows is generally fine enough to be carried into the Columbia River. A small amount deposits behind run-of-the-river dams such as McNary or Bonneville dams and most of the remainder is either deposited in the river below the Bonneville dam or is carried out to sea. Much of the sediment from the Walla Walla and Palouse rivers may be deposited in the river above McNary dam.

Land Capability

Land-capability is an expression of land quality, use limitations and the need for soil and water conservation measures based on differences in physical and climatic features. The physical characteristics of the land are inventoried in order to segregate the different kinds of land which require different use and management for continued production without damage. In the land-capability classification the premise taken is that the best land is that which will produce permanently under cultivation with the smallest number of special management practices. The land-capability classification segregates crop land by progressive steps from land requiring the least special management practices to that requiring permanent cover with numerous

management practices. The classification has three levels of generalization: division, class, and subclass. The two broad divisions indicate land suitable or not suitable for cultivation. The land capability classes indicate the severity of the soil and water conservation problem. The subclasses indicate the specific kinds of soil and water conservation problems which are present. The generalized land use capability of lands in the area is shown on the map, Figure 8.

Land Capability Classes

There are eight land capability classes, in two broad divisions. Classes I to IV are suitable for cultivation and express in progressive levels the intensity of conservation problems, and the intensity of management and treatment required. Classes V to VIII represent lands where cultivation is not recommended and management of the permanent land cover is the prime consideration. Differences in these four classes represent the intensity of cover management required to prevent damage or loss by erosion.

Land Capability Class I is land suitable for cultivation most of the time. It is nearly level land with good soil depth, texture, and profile. It requires only normal tillage and fertility management practices for full crop production common to the area.

Land Capability Class II is land suitable for cultivation more than half of the time. It requires only simple, easily applied conservation practices. It has either slight slope and erosion hazard, slight restriction in soil depth, or profile, or

THE LAND USE CAPABILITY CLASSES

All land is divided into eight broad classes. The first four classes include land which can be plowed and cultivated safely, without lasting damage, if correct conservation procedures are followed. Class I land needs little special conservation treatment. Classes II, III and IV require increasing degrees of care and protection. The remaining four classes are not suited for cultivation. They need the protection afforded by a permanent cover of vegetation. Classes V, VI and VII require progressively more care even when used for grazing or forestry. Class VIII land can be used safely only for wildlife, recreation or watershed purposes.

LAND SUITED FOR CULTIVATION

I — Very good land with little or no limitation or hazard. It is nearly level, deep and without erosion. Some of it may need drainage, clearing or other conditioning measures.

II — Good land with only minor limitations or hazards such as, gentle slopes, moderately shallow soils or slight susceptibility to erosion. Choice in use may be reduced, and conservation practices such as water management, contour operation, cover cropping, etc., are required.

III — Moderately good land with major physical limitations and hazards. It usually is characterized by relatively steep slopes, shallow soils or severe erosion problems. Choice in use is limited and protective measures such as terracing, strip cropping and careful water management, are necessary.

IV — Fairly good land which is suitable for occasional cultivation--usually not more frequently than 1 year in 4. When plowed, considerable care needs to be taken to avoid erosion or other lasting damage.

LAND NOT SUITED FOR CULTIVATION

V — Very well suited for grazing or forestry use. It has little or no physical limitations or hazards when so used but requires good range or woodland management.

VI — Well suited for grazing or forestry use. It has minor hazards and limitations due to moderately steep slopes, shallow soils or susceptibility to erosion.

VII — Fairly well suited for grazing or forestry use. It has major hazards or limitations because of very steep slopes, shallow or droughty soils, or advanced erosion.

VIII — Land unsuited for agricultural purposes, but may be used for wildlife, recreational or watershed purposes.

Figure 8
GENERALIZED LAND USE CAPABILITY
BIG BEND - PALOUSE - LOWER SNAKE SUB AREA
COLUMBIA RIVER BASIN
1951

10 0 10 20 30
SCALE IN MILES

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may be slightly erodible soil requiring some special management practices. Proper management of Class II lands requires that they be in non-cultivated, soil building, and protective crops about one-fourth of the time.

Land Capability Class III is land suitable for cultivation about one-half of the time and requires soil building or protective crops the remaining half of the time. It has restrictions of drainage, moderate to severe erosion hazards, limited soil depth, or coarse or heavy texture. It requires more intensive and complex management practices and more restrictions in use than the preceding classes.

Land Capability Class IV is land suitable for only occasional or very limited cultivation and requires soil building or protective crops to be used on it about three-fourths of the time. Problems of drainage, steep slope, shallow soil, or very coarse or very heavy soil texture impose severe restrictions on cultivation of this class of land.

Land Capability Class V is land not suitable for cultivation, due to adverse climate, poor drainage, or stoniness, but can be used for grazing or forestry with limited conservation practices. Land in this class is located on the headwaters of Crab and Cow Creeks generally in the form of saucer-shaped depressions.

Land Capability Class VI is land not suitable for cultivation, but is suitable for grazing or forestry use and must have a permanent vegetative cover. This class of land has steep slopes, shallow or coarse soils, or is in a zone of precipitation inadequate

for crop production. More intensive management practices are required to maintain protective cover than on Class V land.

Land Capability Class VII is land not suitable for cultivation, but is suitable for limited grazing or for forestry use under a permanent cover. This class of land may be very steep, very shallow, rocky, droughty or alkaline. It occupies the canyon slopes, gravelly and scabland areas and the higher portions of the watershed.

Land Capability Class VIII is land not suitable for cultivation, or the production of harvestable grass or forest cover. This class of land is essentially waste land, in that no harvest of vegetative cover is practical from it. It includes rocky lands, inaccessible steep areas or lands which have unproductive soil conditions which make a commercial vegetative use impractical. These lands may be useful only as wildlife habitats, or recreation areas.

Land-Capability Subclasses

Land capability subclasses indicate the nature or kind of conservation problem, land limitation, or managerial treatment required on the land. They are subdivisions of the land capability classes to indicate the kinds of practices required in addition to the intensity of the conservation problem.

Subclass e - indicates an erosion hazard deduced by steep slope, erodible soils, or the actual soil loss from erosion at some time prior to the date of the soil survey.

Subclass s - denotes problems of the soil; coarse, gravelly or

heavy texture, shallow depth or profile, stoniness, excess alkali, acidity, or nutrient deficiencies. It indicates that adverse soil characteristics cause the land use limitation and the conservation problem.

Subclass c - includes drought, short growing season, arid areas without prospects of irrigation, frost pockets, or excessive precipitation.

Subclass w - indicates poor drainage; excess surface water, high water tables or flood water cause limitations to the full productive use of the land.

Land Suitable for Cultivation

Land Capability Class I land is rather limited in the Big Bend-Palouse-Lower Snake area; there are only 55,000 acres in this class. Most of the area has at least a moderate slope, light soil texture, restricted soil depth, or other features which cause its exclusion. A majority of the bottomlands, with minimum slope and deep soil which usually are Class I land are so situated that they have poor drainage, alkali or saline conditions, or are subject to annual flood hazards. Lands with Class I capability are the Palouse, Snow, Athena and Walla Walla soils in the Palouse region, which are on gentle rolling plateaus, toe slopes, fans, or terraces. The flat terrace land north of Walla Walla is Class I. In the Columbia Basin Irrigation Project the Warden soils, deep friable basin soils lying on gentle to flat relief, and the glacial outwash soils of the Ephrata series three feet or more in depth, lying on a nearly level plateau, are representative of land capability Class I.

In the Columbia Basin Project, Class I lands are used for full crop production under irrigation. In the Palouse region Class I lands are suitable for full crop rotation of wheat, peas and other grains.

Land Capability Class II land is the most extensive in the area. It is generally characterized by extensive areas of light, medium textured soils with gentle or moderate slopes, having a slight water or wind erosion hazard. In the Palouse region Class II land lies on the toe slopes and gentle, moderate south slopes of the Palouse, Athena, Walla Walla and Ritzville soils. In the central part of the area, the deep loessial Ritzville, Walla Walla and moderately deep Burke soils, having gentle or moderate slopes with a water erosion hazard or light soils having a wind erosion hazard in the drier areas are predominantly in land capability Class II. In the Columbia Basin Project the nearly level Ephrata and Othello soils have either shallow soil depth or light soil textures causing them to be in land capability Class II. On the Waterville plateau of Douglas County, Class II land includes the more gentle slopes of the Douglas, Waterville and Burke soils.

These Class II lands, totaling 2,409,000 acres, are used for the normal full range of crop production suitable to the different physiographic areas, but they require soil conserving or protecting crops part of the time to resist water and wind erosion.

Land Capability Class III lands are the second most extensive of the cultivated lands in the area, with a total of 1,898,000 acres. They are characterized mainly by deep soil on steep slopes;

shallow, light textured soils on nearly level slopes; deep bottomland soils with poor drainage; or moderately eroded soils. In the Palouse region, with the rolling topography, Class III lands are on Palouse, Athena and Walla Walla soils on steep north or south slopes, or on more gentle slopes where there has been severe soil loss from erosion. In Adams and Lincoln Counties they are extensive on the rolling hills. In Douglas County, on the Mansfield and Waterville plateau, Class III land is characterized by the shallow, sandy glacial drift of the Touhey soils and the steeply sloping Waterville and Douglas soils. In the Columbia Basin Irrigation Project, Class III land includes shallow, sandy Ephrata soils and the deep coarse textured Quincy soils on nearly level topography. The more steeply rolling deep Ritzville, Wheeler, and Ellesforde soils have an erosion hazard of such intensity as to put them in land capability Class III. Quite extensive areas of Burke and "Taunton" soils, shallow over caliche and on minimum slopes, have restricted drainage requiring irrigation practices which place them in land capability Class III.

Land Capability Class IV lands, totaling 1,592,000 acres, may be found over most of the area, but are not so extensive as those in Class II or III. They are characterized by being so steep, so shallow of soil, or so coarse or heavy of soil texture as to require them to be out of cultivation most of the time. They are essentially cultivated hay and pasture lands.

In the Palouse region Class IV lands are mainly those very steep north slopes with deep Palouse, Thatuna, Athena and Walla

Walla soils. Some ridge land is so severely eroded that it requires protective cover and soil building practices most of the time. Some bottomland is so poorly drained or of such heavy texture that it requires hay and pasture use with only occasional cultivation. In the Palouse these Class IV lands should be used for legumes and grass, either as hay or pasture. In the central part of the area, where dry farm wheat is grown, Class IV lands are the deep soils on very steep slopes, too steep to cultivate, or very coarse textured or very shallow soils which are too droughty for cultivated grain production, and which are suited only for production of grass hay and pasture.

In the Columbia Basin Project, land capability Class IV lands comprise quite diverse physical land conditions. These may include short steep irregular slopes with erodible deep Ellesforde, Sagemoor, and Wheeler soils, which are difficult to cultivate and irrigate, or extensive areas of very shallow or stony outwash Ephrata soils which occur on nearly level plateaus, permitting only limited cultivation.

Other areas of land capability Class IV include: large areas of coarse textured Qunicy soils; many areas of sandy soils, shallow over caliche; in the Frenchman hills, and Saddle Mountains steep lands with moderately shallow soil; in Douglas County very shallow glacial Touhey soils and steeper lands of the Waterville and Douglas soils. In the Palouse area and in the irrigated Columbia Basin Project Class IV lands are used for legume-grass, hay and pasture. Elsewhere in the drier part of the area grass hay and pasture crops are grown.

Land not Suited for Cultivation

In general, the non-cultivated lands in the area are used for range. Climatic conditions favor forest use in only a few places. Some timber grows on Badger Mountain, Douglas County. Scattered yellow pine occurs in southwest Spokane County, and along the banks of the Palouse River. The only extensive forest area is in the Blue Mountains of eastern Washington and northeastern Oregon, and the Potlatch Mountains of western Idaho.

Land Capability Class V land is quite restricted in the area, only 6,000 acres being in this class. There are areas in the irrigated Columbia Basin Project which have moderately deep Ephrata soils, but with so large a content of stone and gravel as to prevent cultivation. These can produce a heavy volume of irrigated pasture grazing with little or no deterioration. Elsewhere in the basin irrigated project are bottomlands with very poorly drained and stony Redrock and Naylor soils which cannot be cultivated without deterioration but which produce good pasture. In the channelled scabland of the central part of the area are "pothole" areas of deep, Link and Colville soils, poorly drained or without practical drainage, but which sustain heavy grazing use. These lands all fall into land capability Class V. Essentially all Class V lands in the area are used for pasture.

Land Capability Class VI lands in the area include large acreages of stony fine outwash soils in the channelled scabland areas, and moderately shallow steep mountainous soils on the plateaus of the timbered area. This class of land, consisting of

1,734,000 acres, includes the better soil and topography conditions found in the rough non-agricultural land of this area. Most of the rough lands, however, fall into land capability Class VII:

Land capability Class VII lands include all of the shallow stony soils on rough mountainous topography or canyon breaks and the very coarse dune sand areas and basalt outcrop lands of the plateau. These lands are quite extensive (1,927,000 acres) and are either so very steep or are of such hazardous soil condition as to require the most extreme grazing care and forest management for soil protection. The Columbia and Snake River gorges have rough broken grazing lands in this capability class.

Land Capability Class VIII lands consist of 48,000 acres of essentially wasteland. They are so inaccessible, so precipitous, or so hazardous, that little grazing or timber harvest can be made. The basalt "pavement" of the Columbia plateau, cliffs and precipitous ledges and slopes of the stream gorges are in this land capability class.

The approximate acreages of lands by land capability classes and major land uses are shown in Table II-4.

The approximate acreages of Land Capability Classes II, III, IV, VI and VII, are shown by subclasses in Table II-5.

Land Cover

The Big Bend-Palouse-Lower Snake area was originally a vast grassland plateau fringed by forested mountains on the north, east and southeast. The first settlement in the area occurred about 100 years ago. Cattle raising and wheat production dominated the

Table II-4.--Land by capability class and major land use - Big Bend-Palouse-Lower Snake Area - 1952

Land Capability Class	Total Area	Cropland	Rangeland	Forestland
	Acres	Acres	Acres	Acres
I	55,000	55,000	0	0
II	2,409,000	2,288,000	21,000	0
III	1,898,000	1,549,000	346,000	3,000
IV	1,592,000	891,000	672,000	29,000
V	6,000	0	6,000	0
VI	1,734,000	73,000	1,443,000	218,000
VII	1,927,000	1,000	1,596,000	330,000
VIII	48,000	0	46,000	2,000
Unclassified 1/	356,000	0	0	0
Total	10,025,000	4,857,000	4,230,000	582,000

1/ The unclassified areas include towns and cities, roads, highways and railroads and other unclassified areas.

Table II-5.--Land by capability class and subclass - Big Bend-Palouse-Lower Snake Area

Land Capability Class	Area of Class	Subclass: Erosion Hazard	Excessive Wetness	Soil Deficiency	Climatic Limitation
	Acres	Acres	Acres	Acres	Acres
II	2,409,000	2,210,000	6,000	190,000	3,000
III	1,898,000	1,431,000	9,000	441,000	17,000
IV	1,592,000	767,000	23,000	765,000	42,000
Subtotal	5,899,000	4,403,000	38,000	1,396,000	62,000
VI	1,734,000	464,000	5,000	1,227,000	38,000
VII	1,927,000	200,000	7,000	1,720,000	0
Subtotal	3,661,000	664,000	12,000	2,947,000	38,000
Total	9,560,000	5,067,000	50,000	4,343,000	100,000

agricultural development from the date of settlement. Severe winters of 1881 and 1890 nearly wiped out the developing cattle industry and helped swing the preference to wheat production. At about the turn of the century or shortly thereafter wheat production under an alternate crop-fallow system was extended to nearly all lands suitable for cultivation.

During the last two decades development of irrigation and annual cropping in areas with adequate rainfall has caused a diversification of land use in the eastern and western portions of the area. In 1950 approximately 50 percent of the area was used for cropland. About 2 percent of the cropland was irrigated.

Range lands account for about 42 percent of the area and are used for grazing by sheep and cattle. The range lands are limited largely to the fringe areas, scablands and "breaks" along watercourses or coulees.

Forests now cover about 6 percent of the area, being only slightly less extensive than when settlement first occurred.

The remaining 2 percent of the area is occupied by roads, railroads, cities and towns or is waste land.

The generalized land use in the area is shown on the map, Figure 9.

Cropland

The cropland area, about 4,857,000 acres, is used for the production of cultivated crops, including hay and pasture. This is approximately 49 percent of the land in the area. The dominant system of cropping being followed is that of a wheat-fallow rotation. Illustrative of this is the acreage devoted to small grains, 2,627,900 acres, and that to fallow, 2,055,900 acres. These two categories account for 96 percent of the total cropland area. Other cropland uses are: row crops, 17,900 acres; and hay and pasture, 145,000 acres; and miscellaneous, 10,000 acres. The above figures are as of 1952.

The area was first settled about 100 years ago. The first settlers were cattlemen, who grazed their herds on the vast acreages of native grasses. As additional settlement occurred it was discovered that the prairie lands of the Palouse and Walla Walla areas were extremely fertile and would produce high yields of

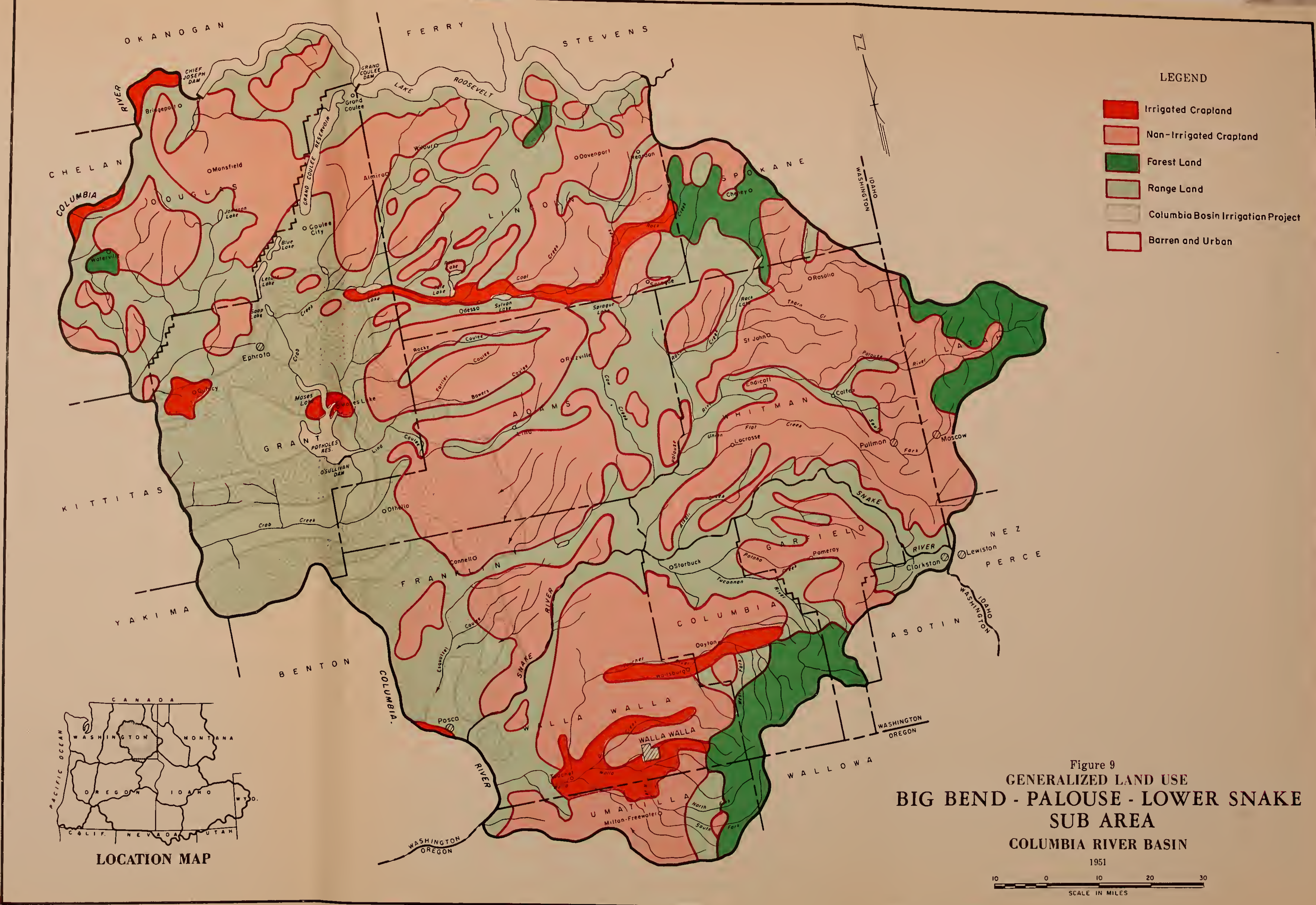

Figure 9
GENERALIZED LAND USE
BIG BEND - PALOUSE - LOWER SNAKE
SUB AREA
COLUMBIA RIVER BASIN
1951

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wheat. The combination of easily subjugated prairie land of high fertility, the coming of rail transportation, and severe winters in 1881 and 1890 which caused widespread livestock losses, created a situation favoring a great increase in the acreage devoted to wheat production. The grazing lands of the Big Bend and other parts of the area were plowed and used for wheat growing. It soon became apparent that dryland farming was hazardous in the drier portions of the area and a substantial acreage was abandoned and reverted to annual weeds or sagebrush. Irrigation has not been extensively practiced until recent years except in the Walla Walla Valley. Small isolated tracts along perennial streams or in the vicinity of Moses Lake have been irrigated for many years. All of the orchard and vineyard and row crops are grown under irrigation. The development of the Columbia Basin Project has enabled additional acreages of land to received irrigation water for the first time. This acreage will be expanded substantially as the project is completed.

The lands of the more arid portions of the area are subject to development of saline conditions whenever drainage is restricted. Development of additional irrigated areas will undoubtedly accentuate this condition.

The cropland areas are subject to two types, and seasons of erosion. In the more humid portions, such as the Palouse and Walla Walla areas, water erosion during the winter and spring months is particularly serious. In the more arid portions, such as the Big Bend and Pasco areas, wind erosion during the spring

months causes serious soil loss, particularly on newly cultivated or bare fields.

The dark brown prairie soils of the Palouse and Walla Walla sections are inherently fertile soils. In their virgin state, they were high in organic content and mineral fertility. Fertility levels have decreased materially under exploitative systems of farming and accelerated erosion is a by-product of such systems. Fertility levels of lands in the more arid portions of the area are lower than in the more humid areas. This is particularly true with respect to organic matter and nitrogen. The use of commercial fertilizers has been gaining in popularity during the last decade. It has been discovered that the use of nitrogen fertilizer enables annual cropping to be followed on a considerable acreage of lands formerly alternately cropped and fallowed.

Rangeland

In 1952 about 4,230,000 acres of the area were used for grazing purposes. This represented about 42 percent of the land in the area. The range lands, for purposes of discussion, may be logically divided into three zones, which are largely differentiated by season of use. These zones are: the high elevation range, the medium elevation fringe areas and the low elevation range.

The high elevation range is all within the forested lands in the eastern portion of the area. The topography, in general, is rugged and the open ridges or "breaks" are separated by dense timber or brush cover. Livestock grazing is very limited in

the high elevation range. It is utilized principally by deer and elk.

In the medium elevation fringe range there is a large area between the altitudes of 2,500 and 4,500 feet known as the yellow pine fringe timbered area. It is located adjacent to the north and east boundary of the area beginning at the Badger Mountains south of Waterville in Douglas County and ending a few miles east of Weston in Umatilla County, Oregon. These lands are characterized by an overstory of western yellow pine and an understory of Idaho fescue, bluebunch wheatgrass, pinegrass in the denser timbered areas, and needlegrasses on the sandy open fringes.

Practically all of these fringe timberlands are grazed by livestock, and most are grazed part of the year by big game. They are, as a rule, in much poorer condition than the other range areas. It is estimated that the depletion of this type from its virgin state has been as high as 70 percent.

The largest area of low elevation range is on the plateau gently sloping from northeast to southwest. These lands vary in elevation from 2,500 feet to approximately 350 feet at the mouth of the Walla Walla River. The broad expanse of plateau is broken by ancient stream beds deeply entrenched in the basalt layers. At present, these gently sloping lands are approximately one-half in non-forested range and one-half in dry-farmed cropland. Under the Bureau of Reclamation's Columbia Basin Irrigation Project approximately 470,000 acres will be converted from range to irrigated cropland. With the exception of a few rimrock areas

along the Columbia River and some particularly steep "breaks" along the Snake and Palouse rivers, all of the range lands are grazed by livestock.

Some of the most productive range in the Columbia Basin is found in this area. It consists of two original ecological climax types, the Pacific bunchgrass and sagebrush-grass types.

The Pacific bunchgrass type is made up chiefly of bluebunch wheatgrass, Idaho fescue, and big bluegrass. It is located within the 10-inch and 20-inch rainfall areas in Lincoln, Spokane, Whitman, eastern Adams, Garfield, Columbia, and eastern Walla Walla counties. Much of the original range of this type has been plowed to make the wheatlands of the Palouse, Big Bend, and Walla Walla areas. Under poor range management some areas of the bunchgrass type have lost their identities, and in the drier fringes sagebrush, rabbitbrush and cheatgrass have replaced the original grasses. It has been estimated that the original Pacific bunchgrass type range now has only 50 percent of its original productivity.

The sagebrush-grass type is characterized by the dominant aspect of big sagebrush on sites with deep soils. On the shallower soils and swales of lava rock, the low or black sage is usually found. This type is found in the 6-inch rainfall zone. Among the sagebrush were many grasses such as the wheatgrasses, fescues, needlegrasses and Indian rice grass. As the ranges were grazed over three-quarters of a century, the sagebrush, relatively unpalatable to livestock, grew even more dominant in height and began

filling up the spaces left free by the removal of grass. At the present time, this type of range is receiving the most abuse of any of the range types. Estimates have run as high as 70 percent depletion in productivity from the virgin state.

Range Types

Ranges are classified by the predominant vegetation that covers the land into forage types and the forage types are classified as to condition. On the approximately 3.6 million acres of non-forested range, about 25 percent is in the excellent and good condition classes, 34 percent in fair condition, and 41 percent in poor condition.

Table II-6.--Range by type and condition class
Big Bend-Palouse-Lower Snake Area

Cover Types	Condition Class: Excellent-Good	Fair	Poor	Total
	Acres	Acres	Acres	Acres
Sagebrush-rabbitbrush-desert shrub	266,575	385,360	517,973	1,169,908
Perennial grass and forb	652,640	797,668	781,059	2,231,367
Meadow	3,061	7,022	12,449	22,532
Annuals		17,890	156,893	174,783
Timbered range				142,000
Totals	922,276	1,207,940	1,468,374	3,740,590 1/

1/ Excluding area that will be irrigated by the Columbia Basin Project.

There are several characteristics resulting from past use that affect range conditions and range use in this area.

One of the invading annual plants, particularly in Franklin and Walla Walla counties and along the Columbia River, is the highly inflammable cheatgrass. The cheatgrass invasion in the Pasco-Kennewick areas has been caused by a high concentration of people and machinery resulting in repeated fires through the years and by repeated grazing use through the winter and into the spring growing season. Another serious condition resulting from these repeated fires and improper grazing use is the exposure of the light, sandy soil to wind erosion. Dunes are started in several areas on this range, and their rehabilitation will be extremely expensive. Another large invasion of cheatgrass has been caused by plowing up submarginal lands for wheat farming in Grant, western Adams, southwestern Franklin, western Walla Walla, and western Whitman counties. The rainfall has proved too scanty to sustain dry-farming and the land has been abandoned to the inflammable, shallow-rooted annual cheatgrass.

In the northeastern quarter of this area there are numerous "potholes" and small lakes which support a meadow type vegetation fairly late in the summer. Along some of the creek bottoms in Latah and Whitman counties there are also sub-irrigated meadows. As there is a serious lack of adequate summer range in this area as a whole, these high producing meadows often receive excessive use.

With the exception of the very high timbered elevations, all

the range land, totaling about 4.2 million acres, is grazed by domestic livestock. About 85 percent of this total is owned and operated by private individuals, and 15 percent is administered under lease and permit by state and federal agencies (Forest Service, Bureau of Land Management, and Bureau of Reclamation).

About 280,000 acres of the high elevation range, being inaccessible to domestic stock, are grazed by deer and elk. On the fringe areas, on the head of the Palouse River, and along the Blue Mountians, the range is shared by big game and domestic livestock.

It is estimated that there are approximately 45,000 deer and 11,000 elk in herds of 700 to 800 in the eastern timbered regions. Over half the deer population and all of the elk are located on the Umatilla National Forest and the private timberlands lying adjacent along the Blue Mountains. During winters of particularly heavy snows in the headwaters of the Walla Walla and Tucannon rivers, elk and deer have concentrated on some cropland, range, and private forest land adjacent to the National Forest.

Like other broad acreages of range in the Columbia Basin, a large percentage of this area lies in the rain-shadow of the Cascade Mountains. Over 70 percent of the precipitation comes in late fall, winter, and early spring. Plants are dependent on what winter moisture remains in the soil for the coming growing season and early spring rainfall for vegetative growth and reproduction. Sometimes this early spring moisture is very limited or lacking, and a drought condition exists. The perennial bunchgrasses

can vary in production up to 200 or 300 percent, and the annual cheatgrass as much as one thousand percent from average production.

Forest Land

Forest land within the area amounts to 582,000 acres, or roughly six percent of the total area. A little more than 108,000 acres, or about 19 percent of the forest area, is classed as noncommercial. The commercial types, including stands of all ages and conditions and producing or capable of producing commercial timber, are as follows:

Type	Area, Acres
Douglas-fir	29,700
Ponderosa pine	258,200
Spruce-fir-hemlock	117,500
Western white pine	60,400
Lodgepole pine	7,300
Western hardwoods	700
Total commercial forest	473,800

Generalized forest types in the area are shown on the map, Figure 10.

The ponderosa pine type occurs at the lower and middle elevations. Covering 44 percent of the forest area and located where accessibility is easiest, this type provides most of the commercial timber cut. Rather open stands are found on the ridges along the northeastern side of the area; fringe forest that is extensively used for grazing. In the headwaters of the Palouse River in the

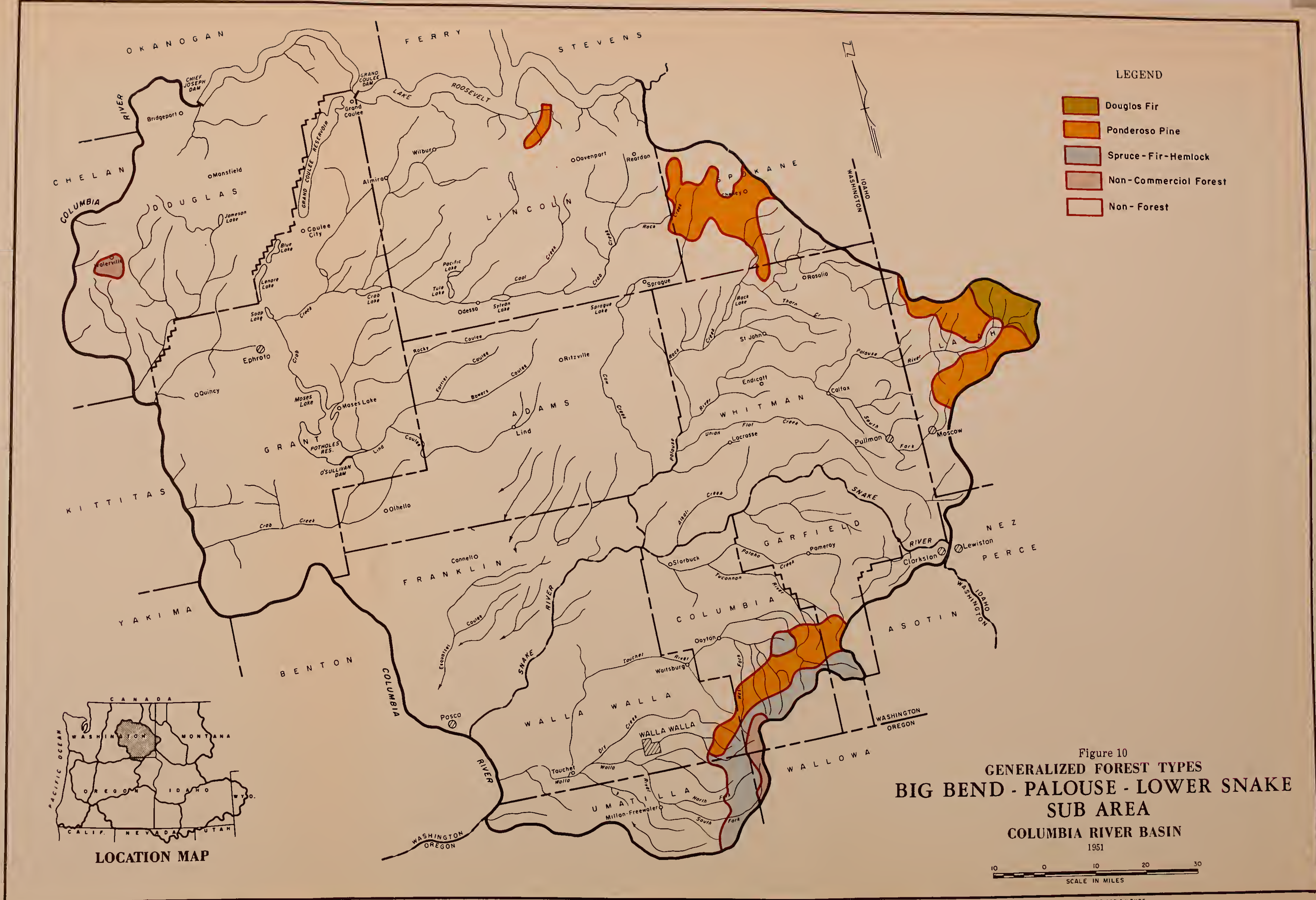

Figure 10
GENERALIZED FOREST TYPES
BIG BEND - PALOUSE - LOWER SNAKE SUB AREA
COLUMBIA RIVER BASIN
1951

Idaho portion of the area, and in the Blue Mountains along the southeastern edge, good commercial stands have developed.

Above the ponderosa pine type, a mixed conifer forest of spruce, larch, fir, hemlock and Douglas-fir becomes predominant. At the extreme eastern end of the area, in the Idaho mountains, the forest is principally white pine. Together with the ponderosa pine, the white pine in times past made up the bulk of the commercial forest. More recently, logging has begun in the spruce-fir-hemlock types.

Noncommercial forest includes alpine types and fringe types with stands too open, volume too low, or accessibility too difficult for harvesting economically. In the higher elevation it includes alpine fir, mountain hemlock, and lodgepole pine; on the lower fringes, poor quality ponderosa pine. This forest type may, however, provide considerable grazing capacity and support numerous big game animals part of each year. Where it occupies the high elevations with greatest precipitation, the noncommercial forest type is important as watershed cover.

Prior to the last decade, most logging was confined to the ponderosa and white pine types. Logging was done largely on a tree-selection basis, and resulted in a high-grading of the stands. Other conifers made up the bulk of the stand left uncut, in some instances leading to a type conversion. As the demand for timber has increased in recent years, logging has moved farther back into the forest area. All species are harvested, though the two pines named are still the most important.

In the early logging, slash was generally disposed of by broadcast burning. Most of the older cut-over areas have been burned heavily, and are not yet satisfactorily restocked with young trees. More recently, though slash disposal is less destructive, the use of heavy machinery has at times caused serious damage to young growth and occasionally to the soil.

Though limited in extent, the forested lands of the area are of considerable importance to the water economy. Normal rainfall varies from six inches on the west side to twenty inches on the east at lower elevations, but increases to about fifty inches in the forested higher mountains. Over about two-thirds of the entire area the runoff averages one inch depth, but in the mountains increases to twenty inches or more. The forested six percent contributes thirty percent of the total water yield. Used both for irrigation and for municipal domestic and industrial supply, this water yield represents one of the more important crops from the forest land.

On the high elevation noncommercial forest areas, watershed considerations are paramount. Though these lands are also used for big game production, grazing by domestic stock, and recreation, water has the principal value. These upper areas receive most of their precipitation as snow, and carryover water, stored as snow, for gradual release as spring and summer season stream flow. The lower lying ponderosa pine forest and the noncommercial forest fringes in the foothills yield very little water because they receive much less precipitation.

Other Land

All land within the area not classified as cropland, range or forest land has been classed as "Other Land".

The various uses of land included in the approximately 231,000 acres of "Other Land" in this area are considered in five categories.

Urban developments. Cities, towns, parks, golf courses, and other urban developments. Such cities and large towns as Walla Walla, Pasco, Colfax, Cheney, Davenport, Ephrata, and others constitute a large percentage of the approximately 196,000 acres of land in this category.

Roads, railroads, and rights-of-way. The area is covered with a network of highways, county roads and railroads with fenced rights-of-way. With the additional irrigated land and population increase resulting from the Bureau of Reclamation's Columbia Basin Project, there will be additional land included in road and canal rights-of-way.

Waste land includes land that has no vegetative cover or is so steep or rocky that it cannot be used by man or livestock. Examples of this type of land are lava flows, steep rimrocks and breaks along the canyon walls, sand dunes, and similar areas of unusable land. This is a small percentage of the "Other Land" acreage.

Farmsteads. The ranches are relatively large in this area; hence, farmlots, corrals, buildings, etc., account for only a relatively small portion of the total area.

Military installations include airports, supply depots, etc. There are military airport installations in two counties, Franklin and Grant, containing approximately 3,000 acres.

ECONOMIC DEVELOPMENT

Population

The population of the Big Bend-Palouse-Lower Snake area was 168,000 in 1950, or an increase of 85 percent since 1900. The growth has not been steady. Population increased by 62 percent from 1900 to 1910 but declined in numbers during the next two decades. In 1930, the population was 122,000, only 35 percent less than in 1950. Between 1940 and 1950 the population increased by 26 percent.

Table II-7.--Population distribution and trend

	1890	1900	1910	1920	1930	1940	1950
	No.	No.	No.	No.	No.	No.	No.
Urban	15,136	26,960	57,145	54,854	53,343	57,049	90,429
Rural	51,243	63,797	89,672	79,872	68,856	75,651	77,370
Total	66,379	90,757	146,817	134,726	122,199	132,700	167,799

The greatest rural population was attained in 1910, when 90,000 persons were classified as rural. This was 61 percent of the total population. In 1950, only 77,000 persons were classified as rural, and this number had changed only slightly during the previous 20 or more years. In the latter year, rural population accounted for only 46 percent of the total population.

The greatest growth has been in urban population. Only 27,000 persons lived in urban areas in 1900 as compared with 90,000 in 1950. From 1940 to 1950 the urban population increased by 58 percent while rural population remained practically stationary. This increase was about the highest in the Columbia River Basin Area and it can be attributed largely to the atomic energy program.

The largest city in the area is Walla Walla with a population of 24,102 reported in 1950. Pasco and Moscow reported slightly more than 10,000 population while Pullman had 12,000. These four cities accounted for 62 percent of the urban population of the area. In addition to these cities there were many smaller towns all of which had populations under 5,000 in 1950. Spokane, with a population of 162,000, is just outside of the area. Economic activity in the area is closely tied in with that centered in Spokane.

For the entire area there is an average density of 11 persons per square mile. The density ranges from a high of 31.2 persons per square mile in Walla Walla County to a low of 3.5 persons per square mile in Adams County. The density is greatest in the areas immediately adjacent to the three largest cities.

In the area 35.3 thousand persons live on farms, or an average of 3.9 persons per farm. The figure is the same as the average for the entire Columbia River Basin Area. The farm population is 21 percent of the total population, or 39 percent of the rural population.

In April, 1950 more than 62,000 persons in the area were

employed. The largest group was employed in agriculture, with more than 14,000 persons employed. The retail trade was second with 9,100 employed. This was followed by the construction industry with 8,900 and by professional and related activities with 8,700. This latter group included persons in medical, educational, and other professional groups. The location of two land grant colleges in this area is largely responsible for the size of this group.

Although agriculture provided employment directly for only 14,000, large numbers of persons find employment in agriculture particularly during harvest season. In addition, many other economic activities such as transportation, wholesale trade, retail trade and others involve services of primary importance to agriculture. The importance of agriculture as a source of employment is much greater than indicated by the number employed in April, 1950.

Water Resources

The Big Bend-Palouse-Lower Snake area is, for the most part, a water deficient area. Only the small sections of the area comprising the Blue and Potlatch Mountains have a water surplus. This surplus, ranging from about 12 inches runoff per year in the Potlatch Mountains to some 36 inches per year on the headwaters of the Walla Walla River in the Blue Mountains, is variable from year to year. In only five years of record, the flow of the Palouse River near Potlatch, Idaho varied from 42 percent to 136 percent of the five-year average. The South Fork of the Walla Walla River, near Milton, Oregon in 12 years of record had a low flow of 71 percent of the average and a high of 140 percent.

Over 75 percent of the seasonal flow of the Palouse River near Potlatch occurs in the three-month period March-April-May. Forty percent of the average seasonal flow of the South Fork of the Walla Walla occurs in the same period. Outside of this period, March through April, the flow of the Palouse is very low. This indicates that storage is essential if the flow of the Palouse is to be used for power, irrigation and municipalities. The Walla Walla, on the other hand, has reasonably well sustained flows through the period November through July. Stream flow through the late summer and early fall is also fairly well sustained. This more uniform flow throughout the year probably accounts for the present power and irrigation developments on this stream, as contrasted to the Palouse River where practically no developments have taken place.

Short-time records of stream flow and observations indicate that the principal mountain streams between the Palouse River and the South Fork of Walla Walla have water yields and stream flow patterns between the extremes of the Palouse and South Fork of the Walla Walla River. Firm water yields in all these streams is low due to periodic dry years. The stream flow pattern is such that storage is necessary before it is possible to develop the available water for power, irrigation and municipal use.

Irrigation

Irrigation in the area has developed to the extent of available, dependable and cheap water supply. Because flow of the Walla Walla River holds up relatively late into the summer, most

of the irrigation development to date has been in that locality. Of approximately 60,000 acres irrigated, 24,000 are with Walla Walla River water. Small areas along the Snake and Palouse rivers are irrigated by pumping from the streams. Some of the alluvial bottoms along Crab and Wilson Creeks are flood irrigated by the spring runoff and a limited acreage is watered from wells in the vicinity of Moses Lake and Mesa.

Table II-8.--Irrigated lands by counties

County	Total Irrigated Acreage 1949	Total Irrigated Acreage 1944	Sprinkler Irr. 1949
	Acres	Acres	Acres
Adams	1,237	170	133
Columbia	2,373	1,890	482
Douglas	8,428	6,485	2,311
Franklin	4,453	2,012	1,479
Garfield	934	242	184
Grant	14,286	7,561	909
Lincoln	1,696	780	230
Walla Walla	24,323	16,360	10,203
Whitman	2,045	900	1,145
Latah	31	0	6
	59,806	36,400	17,082

The first water of the Columbia Basin project was turned into the canals in the fall of 1952, which marked the beginning of irrigation on the million acre Columbia Basin project scheduled for development in the near future.

Manufacturing

The census of manufactures in the U. S. Department of Commerce for 1947 indicates that there are approximately 130 manufacturing establishments dispersed throughout the area. They employ about 5 percent of the workers and add about 22 million dollars to the value of the raw material processed. Food processing and lumber making together account for 61 of the total number of plants. Other products from metal, wood, stone, clay and glass are made in 39 establishments while 20 are devoted to printing and publishing.

For most manufactured items the area is decidedly a deficit zone into which most processed material is imported. Wheat, the principal crop, is more easily handled as a raw than a manufactured material and is, for that reason, shipped to consuming centers for milling. Green peas, being quite perishable in the raw state, are canned or frozen before export, as are asparagus and some fruit.

The miscellaneous manufactured items of furniture, foundry products and fabricated metal are largely for consumption within the area and depend on locally available raw materials or the importation of fabrication elements.

Since peas and trees provide most of the raw materials for processing, the plants are located in the eastern and southeastern parts around the towns of Potlatch and Moscow, Idaho; Dayton, Waitsburg, and Walla Walla, Washington; and Milton-Freewater and Weston, Oregon.

Sugar, cheese, vegetable and meat products will probably be added to the items manufactured for export when the region is more fully developed through irrigation.

Domestic Water Supply

The availability of domestic water supply depends on location. Abundant supply originating in the mountainous eastern edge contrasts with a frequent deficiency in the central and western parts of the area. Average runoff in excess of 800,000 acre feet from the watersheds of the Palouse, Tucannon, and Walla Walla rivers indicate a plentiful supply for the east half of the area. Years with no runoff occur quite frequently in the western portion of the area which includes the Columbia Basin Irrigation Project.

Various methods of obtaining domestic water supply are used. Reservoirs, direct diversion from streams and wells provide most of the urban or community supplies. For individual supply the source depends on location. Springs, streams and wells provide water in the eastern half of the area, but approaching the Columbia River the ground water is deep and unpredictable except in a few favored areas. In many cases water is hauled in barrels, cans and tanks, which is presumably a temporary means of supply until a better method is provided. Group and community wells, cisterns and reservoirs to be filled from irrigation canals are the alternative methods used. Inadequate domestic water in many cases may limit the type of farm enterprise as well as industrial development. Dairies, for example, require a large amount of water in their operation.

About 3,000 acre feet of water are used annually for domestic supply of approximately 170,000 population. Most of the expected increase in population will be in the dry western zone where water scarcity already exists.

Fisheries

Although the Columbia and Snake Rivers still carry spawning runs of salmon and steelhead trout, few of the fish make use of the tributary streams within this area. Small runs of silver salmon and steelhead are found in the Walla Walla and Tucannon rivers. Over the years these runs have been greatly diminished or completely stopped by diversion of irrigation water, by pollution from industrial wastes, and by destruction of the spawning grounds. Irrigation diversions dry up sections of the streams at critical times, or cause harmful increases in temperature in the remaining stream flow.

Agricultural Resources

Number and Size of Farms

In 1950 slightly less than 9,000 farms were reported in the area. The number of farms in this area has decreased almost steadily since 1910. In that year, the census reported 15,000 farms. Between 1940 and 1950, the number of farms decreased by 16 percent.

Although the number of farms decreased by 40 percent from 1910 to 1950, land in farms increased by 20 percent. The combination of these two factors meant that the average size of farms increased from 429 acres to 921 over this period. Mechanization has

been the key to expanding farm sizes in this area. The greatest percentage increase in any decade was from 1940 to 1950 when the average size increased by 31 percent.

This area with 82 percent of the total land area in farms has proportionately more land in farms than any other area in the Columbia River Basin Area. The Deschutes-John Day area, which rates second, has only 53 percent of its area in farms.

In the area, 9 percent of the farms are less than 10 acres in size, 13 percent from 10 to 50 acres in size, 18 percent from 50 to 260 acres, 33 percent from 260 to 1,000, and 27 percent 1,000 acres or over. The average size of farms in Latah County, Idaho, 258 acres, was the lowest average for any county in the area. At the other extreme, Adams County, Washington had an average size of 1,835 acres per farm. Five of the 10 counties in the area had average sizes in excess of 1,000 acres per farm.

Although this area includes only 5 percent of the farms in the Columbia River Basin Area, it contains 15 percent of the farms with 260 to 1,000 acres and 25 percent of the farms with 1,000 acres or more.

Farm Land Use

There are approximately 8.3 million acres of land in farms, of which about 5 million acres are classified as cropland. The crop land represents 60 percent of the land in farms.

In 1950, 2.7 million acres of cropland were harvested, an additional 2.0 million acres were in cultivated summer fallow, and another 0.3 million were in cropland pasture or other cropland use. Range land on farms involved 2.7 million acres.

Type of Farming

The Big Bend-Palouse-Lower Snake Area is predominantly a wheat and small grain producing area. The eastern counties in Washington, including the southwestern part of Spokane County, and Latah County, Idaho, produce wheat and peas. The remainder of the area is predominantly a wheat type.

According to the 1950 U. S. Census of Agriculture, almost 5,400 farms or 60 percent were classified as field crop farms which produce grain as a cash crop. In addition to the farms producing grain as a cash crop, there were 700 livestock, 400 fruit, 300 dairy, 300 general, 160 poultry and 130 vegetable farms.

Principal Crops and Livestock

Wheat is the most important crop grown in the area. In 1950, wheat was harvested from 2.2 million acres, or 83 percent of all cropland harvested that year. Forty-five percent of all wheat acreage in the Columbia River Basin is found in this area.

Other small grains, including barley, oats and rye, were harvested from slightly more than 100,000 acres. Dry field and seed peas were harvested from 164,000 acres and fresh peas from an additional 31,000 acres. Of the total acreage of dry field and seed peas harvested in the Columbia River Basin Area, 57 percent come from the Big Bend-Palouse-Lower Snake Area. Also, almost a third of the fresh peas come from this area.

Hay was harvested from only 107,000 acres. Only relatively small acreages were devoted to other crops such as grass and

cover crop seeds, fruits, vegetables (other than peas), potatoes, and sugar beets.

With such a large percentage of land in farms and with such a large percentage of farm land in crops, livestock is not as important in the farm economy as in other areas in the Basin. Only 206,000 cattle and calves were reported by the U. S. Census of Agriculture in 1950, with almost 11 percent of these reported as milk cows. In addition, there were only 41,000 hogs and 139,000 sheep and lambs. Poultry was also of relatively minor importance with only 371,000 chickens four months or older and with only 69,000 turkeys raised in 1949.

Farm Income

The value of all products sold averages $14,500 per farm in the area as compared with an average of only $5,400 per farm for all farms in the Columbia River Basin Area. According to the 1950 U. S. Census of Agriculture, farmers in the area sold products whose gross value was in excess of $129 million, made up of crops, $111,000,000; livestock products, $18,000,000; and forest products $145,000. More than 85 percent of this came from the sale of farm crops with only 14 percent from the sale of livestock and livestock products. The relative importance of cash crops as a source of income was greater in this area than in any other area in the Basin.

Commercial farms make up 83 percent of all farms reported by the U. S. Census of Agriculture in 1950. This area included 23 percent of all farms reported in the Basin with value of products amounting to $25,000 or more. Almost 56 percent of the commercial

farms had incomes of $10,000 or more as compared with only 23 percent for the entire Basin. On the other extreme only 13 percent sold farm products valued at less than $2,500 in the area as compared with 30 percent for the entire Basin.

In addition to the 7,404 commercial farms there were 1,560 farms classified largely as part-time or rural residential farms. This included 758 part-time farms which sold farm products worth from $250 to $1,199 but where the operator worked 100 days or more off the farm or where he had income from other sources in excess of the value of farm products sold. The 785 farms classified as rural residences were places where the products sold amounted to less than $250. It is estimated that these part-time farms and rural residences account for less than one percent of the value of all farm products sold.

Irrigation

At the present time irrigation is of relatively minor importance in the Big Bend-Palouse-Lower Snake area with irrigation reported on only 1,676 farms in 1950. These farms had a total of 137,000 acres of cropland harvested, but only 47,000 acres, or 35 percent, of this were irrigated.

Farms with irrigated land have only a small acreage. More than 40 percent had less than 10 acres irrigated with only 8 percent with 100 or more acres irrigated. Most of the potatoes, sugar beets, and fruits grown in this area were harvested from irrigated land. These three crops accounted for about 15,000 of the 47,000 acres irrigated.

This area is now undergoing significant changes. It is estimated that the Columbia Basin Irrigation Project of the Bureau of Reclamation will make irrigation water available from Roosevelt Lake for a million acres of land in the Big Bend area. This will mean the creation of many new farm units and a change in land use from dry land and range to intensive irrigated use.

Tenure

This area, with 24 percent of the farms operated by tenants, has a higher proportion of tenancy than any other area in the Columbia Basin. Also, almost a third of the farm operators were part owners with part of the land owned and part rented. Two-thirds of the tenants rent the land on share-crop basis. In this area, less than one hundred operators have permits to graze livestock on federal lands.

Forest Resources

History of Past Use

The forest resources of the area, while small compared to those of adjacent areas, play a significant part in the economy. Logging began fairly early, and through the 1920's was done without much regard to the future. Slash was disposed of by broadcast burning, and little provision was made for growing a new timber crop. As a result, much of the cut-over area is now poorly stocked. Extension of farm land has also cut into the forest area.

Old growth stands remaining are those from which the best ponderosa and white pine timber has been removed, scattered small blocks for some reason left uncut, and stands in remote areas.

Timber is still being harvested in some localities, but a fairly large proportion--at least on private land--is taken for fuelwood. Because of the careless methods of early logging, former widespread fire occurrence, and excessive grazing use, nearly half the area suffers from moderate to extensive depletion of cover.

Raw Material

About 100,000 acres of the forest area occurs in three of the six counties in Washington north of the Snake River. An additional 174,000 acres are located in the Idaho portion of the area. The remaining 308,000 acres of forest occupy the three counties in Washington south of the Snake River in the Blue Mountains.

Of the 582,000 acres of forest area, 258,000 are in ponderosa pine, 118,000 in spruce-fir-hemlock, 60,000 in western white pine (all in Idaho), 30,000 in Douglas-fir, 7,000 in lodgepole pine, and 109,000 in non-commercial types including aspen, birch, cottonwood, fine needle pine, etc. In terms of area, volume, value, and usefulness, the ponderosa pine is the most important type. Western white pine is next in importance. The spruce-fir-hemlock and Douglas-fir and lodgepole pine types are not so desirable commercially, though they are cut to a limited extent and for some special uses.

Ownership of the forest lands is 47 percent private, 47 percent federal, and 6 percent state. In terms of the 474,000 acres total commercial forest land, 52 percent is in private ownership, 41 percent federal, and 7 percent state. Of the total Federal holdings, 99 percent are national forest, in the Umatilla and

St. Joe National Forests. Except for a 20-acre park in Idaho and 965 acres of municipal watershed in Washington, there have been no withdrawals or reservations in the commercial forest area.

Some 240,000 acres of the commercial forest are classed as bearing saw-timber stands, while 104,000 acres have pole stands. The remainder supports poorly to well-stocked stands of saplings and seedlings. A third of the saw-timber volume is ponderosa pine. Principal area of commercial forest lies in the Blue Mountains and in the Idaho portion of the area.

Volume of saw-timber is as follows:

Ownership	Volume, MM bd. ft. International
National forest	921
Other Federal	6
State	71
County and private	829
Total	1,827

Volume of all commercial timber is as follows:

Ownership	Volume Millions of cu. ft.
National forest	292
Other Federal	3
State	29
County and private	231
Total	555

Depletion and Present Use

The current drain, including insect, fire, and disease losses, on saw-timber is higher than in 1948, approaching 30 million board feet. Ponderosa pine provides two-thirds of the cut, though it makes up only one-third of the standing timber volume. Most of

this timber moves through four sawmills in the area. Sawlogs account for 90 percent of the cut, the remainder being poles, piling, and fuelwood.

Saw-timber production in 1948 was as follows:

Species	Volume, MM bd. ft. International
Ponderosa pine	16.1
Douglas-fir	4.5
Balsam firs	1.3
Western larch	1.1
Western white pine	1.0
Total	24.0

The trend in cutting drain has been upward in the last decade, though the total cut has been well below that taken prior to 1930. Net growth is estimated at 30 million board feet, International rule, per year for saw-timber; and 16 million cubic feet per year for all timber. It exceeds drain from all causes (timber harvest, fire loss, insect and disease losses) by a small margin. Because of past treatment of the forest, however, much of the net growth is being made by the less desirable timber species.

Present cutting in the ponderosa pine type is selective, but is aimed at removal of slow-growing trees, or those subject to insect attack, rather than at taking only those with highest timber value. Better reserve stands are left, and less damage is done to the young trees. Old stands contribute only about half of the present cut. Cutting is, however, disproportionately heavy in the ponderosa pine, and thus to some extent favors regeneration of other species and conversion to other types. Cutting is about 18

percent on national forest lands, 7 percent on other public lands, and 75 percent on private lands.

Employment in the timber harvest and in lumber manufacture takes the time of about 1,500 men. This employment, at least in the harvest, tends to be seasonal rather than full time. Values added by manufacturing are estimated at $1,100,000 annually.

Supplemental income to farms from farm woodlands is estimated at $100 per farm per year, on such farms as have woodlands.

Other Resources

Wildlife

The wildlife resource consists of big game animals such as elk, deer, and bear; small game such as rabbits; furbearers such as mink, muskrat, and beaver; migratory waterfowl in season, plus a local population of ducks and geese; and upland game birds, including blue and ruffed grouse on the forest lands, and pheasants and partridge on the range and crop lands.

Game census counts show an estimated 11,000 elk in the mountains; 45,000 deer in the mountains, foothills and along the breaks of the main rivers; and 330 bear in the mountains and foothills. The furbearers are well stocked in the upper areas, as are the grouse. Ringneck pheasants and Hungarian partridge, both introduced species, are fairly numerous in the agricultural and on some of the range areas. The practice of clean tilling in wheat farming has somewhat reduced the extent of acceptable pheasant habitat.

Small fur-bearing animals, water fowl, and some of the big game population live in or on the margins of streams. Tree and

brush cover along the banks provide shade, protection and food. Condition of this habitat varies with land use and management that affect the cover or that affect stream flow volume, seasonal distribution, temperature, and quality. Sedimentation that has killed food plants and reduced the numbers of food fish, brush-clearing along channel banks that has removed the cover, irrigation diversions that have cut summer stream flow to a minimum, all have had adverse effects on the wildlife in the more intensively developed lowland areas. Only along the mountain streams are environmental conditions and animal populations more or less as they were originally; and even here there has been some damage.

Not all the developing trends are unfavorable to wildlife. Creation of lakes and ponds in the irrigated areas tends to increase the numbers of wildfowl and pan fish. Additional cultivated and watered areas generally increase the population of pheasant and quail.

Value ascribed to the wildlife crop is indicated by the number of users and the time spent. Big game hunting drew 22,000 people for an average of four days each. Small game hunting drew 17,000, for an average of two and a half days each. Fishing attracted 24,000 fishermen, for an average of three days each. In terms of man-days spent on its pursuit, wildlife has a very high value.

Big game harvest counts show that only one-fifth of the hunters in the area are successful. The most recent hunting season tally showed a catch of 4,700 deer, 1,110 elk and 40 bear. This harvest amounts to about 10 percent of the estimated big game population.

Certain areas have been reserved especially to protect wildlife. The Lake Lenore National Wildlife Refuge of 6,201 acres, and the Turnbull National Wildlife Refuge of 15,964 acres, have been set aside for migratory waterfowl. Three more such refuges are proposed; these will add another 25,000 acres. The many small lakes and streams of the plateau constitue an important nesting area. Several species of ducks and geese either nest in the area, or spend considerable time during the migration season resting; and feeding in the nearby grain fields.

At the extreme eastern edge of the area, the Idaho Cooperative Wildlife Research Unit has established a 1,000 acre study area on Moscow Mountain. Studies of deer habitat and herd production, and of ruffed grouse habitat and production are being made. The University of Idaho and the Idaho State Fish and Game Department are cooperating in the work.

The State of Washington operates hatcheries for trout at Walla Walla and on the Tucannon River; and has a game farm for pheasant in Walla Walla County. The State also has a big game range in Garfield County, set aside to provide winter forage.

Certain other reservations have in effect protected wildlife. The Walla Walla domestic water supply comes from a 21,740-acre reservation at the head of Mill Creek, an area formerly closed to livestock grazing and to hunting. Watershed damage by elk in the area resulted in the area being opened to hunting in recent years to reduce game numbers.

Recreation

Within the area wide recreational use of the forest land is increasing. Hunting, fishing, picnicking, and skiing are forms of recreation indulged in; and of these, hunting attracts the greatest numbers of people. There are no special recreation areas reserved solely for that purpose.

Of the forms of recreation associated with the water resources of the area, fishing is perhaps the most important. The mountain streams support numerous trout, and furnish sport to an estimated 24,000 fishermen each year. Steelhead, salmon, sturgeon, and other species furnish sport and food for fishermen in the main rivers. The pothole ponds and the lakes in the northeastern part of the area support populations of various species of pan fish that provide recreation to many anglers. They also provide resting points and refuges for waterfowl with consequent hunting opportunities.

The table following shows the extent of recreational use:

Table II-9.--Recreational use of watershed lands

Item	Year			
	1930	1940	1947	1950
Area population	122,200	132,700	--	167,920
Recreation use*	15,900	113,320	368,200	417,900

* Including both Federal and state lands.

The tremendous increase in use is related to several factors: better transportation, improved access, and more free time to spend on recreation probably being the most important.

The winter snowpacks in the Blue Mountains at the extreme southeast are used by skiers from nearby communities. Skiing is a sport of constantly increasing popularity; and though facilities in this area are very limited as compared with other parts of the Basin, ski enthusiasts take advantage of every suitable locality.

Minerals and Mining

Important mineral discoveries and their development have occurred adjacent to, rather than within, the area. Towns in the eastern part of the area, such as Walla Walla, began their early development, in part, as stage stops on the route to the mines in the Coeur d'Alene district of northern Idaho. Mineral prospecting in the Moscow Mountains and panning for gold along the Columbia and Snake Rivers has contributed in a minor way to early settlement.

The basalt flows and wind-borne soils that make up most of this area are not rich in minerals. The greatest concentration occurs in the headwaters of the Palouse River north and east of Moscow, Idaho. Non-metallic minerals such as gems, pottery clays and feldspar have been found in the locality but not extensively developed. High alumina clay found in the upper Palouse watershed is the only metallic mineral discovered, except gold along the Snake and Columbia Rivers. Deposits of silica sand are located in Grant and Whitman Counties, Washington, and Latah County, Idaho. Another abrasive mineral, pumicite, is found in Franklin and Columbia Counties, Washington. A thin, coal seam is located near Pullman in Whitman County.

The principal commercial mineral resource is road gravel and sand and gravel for building purposes. This material is obtained from river and glacial terrace deposits and fractured basalt flows. The other commercial development of mineral resources is the conversion of silica sand to carborundum. A plant is located in Douglas County, Washington across the Columbia River from Wenatchee. There are several other localities where commercial quantities of abrasives are available, but they have not been developed.

Before 1900 there was considerable placer mining for gold in the Palouse drainage. The deposits have apparently been worked out, and there is no activity now. Low grade mica deposits were worked at one time, also. Lode and placer mining operations are limited and sporadic, and contribute little to the economy of the area. In Garfield County, Washington, there occurred the only recent mining. A placer operation took out 31 ounces of gold and 10 ounces of silver for a total value of about $1,100. Though this work increased the sediment load in the stream where it was done, the problem is local. In general, mining in this area is too limited to present any real problem.

Utilities and Power

Five REA borrowers, including four rural electric cooperatives and one public power district, have rural service areas which lie wholly or in a major part within the boundaries of this area. As of December 31, 1952 these borrowers had received loans totaling $14,661,280 for the purpose of constructing 7,553 miles of line to serve 15,044 farmers and other rural consumers. Total

advances of loan funds on that date were $11,626,428, and 6,848 miles of line (including 61 miles of transmission line) had been constructed to serve 12,563 consumers. Farm consumers accounted for 59 percent of this total. It is not practical to determine the exact number of farms without central station electric service in this area, but available data indicates that more than 90 percent of the farms are electrified.

The five REA borrowers in this area purchased a total of 217,475,000 kilowatt hours of electric energy during the 12 months ending December, 1952. For the month of December 1952, farm consumption averaged 766 kwh.

Hydroelectric Power

Hydroelectric power is produced on only the Columbia and Walla Walla Rivers. Installed capacity of 878,000 kilowatts at Grand Coulee and Rock Island dams and 4,000 kilowatts on the Walla Walla River provide electric power for the homes and business of the area. Plans for future hydroelectric development would raise the generating capacity of the Columbia, Snake and Walla Walla Rivers to an estimated 5,667,000 kilowatts.

Rural use of electricity on the 9,000 farms of the area amounts to about $90,500.00 annually with an average monthly use per farm of $11.80 for the farms reached by a power line.

At present, no REA funds have been loaned for rural telephone facilities in this area. As of April 1, 1950, 73 percent of the farms had telephone service.

Table II-10.--Number of farms having electricity - 1950

County	Total Farms	Farms with Electricity
	No.	No.
Adams	602	539
Columbia	402	307
Douglas	1,001	833
Franklin	331	327
Garfield	320	239
Grant	538	483
Lincoln	1,067	945
Walla Walla	1,228	1,087
Whitman	2,018	1,952
Latah	1,457	1,344
	8,964	8,056

Transportation and Commerce

Only a third of the farms are located on hard surface roads. Almost 53 percent are located on gravel or otherwise improved roads. Although almost 15 percent of the farms are on dirt or unimproved roads, 22 percent of the farmers must travel one mile or more over unimproved roads to reach their usual trading center.

Two-thirds of the farmers must travel at least five miles to reach the usual trading center with slightly more than one-half of these traveling over 10 miles to that center.

The overall highway system for the present types of farming is probably adequate except for the condition of the roads. With the settlement of the Columbia Basin Irrigation Project, the present road system is far from adequate and will need to be greatly expanded to serve adequately the new areas being opened up for irrigation.

The Columbia and Snake Rivers have been used as transportation routes since the first fur trapper entered the area. The pioneer boat of the river freight traffic began operation in 1859 to a terminal at Wallula, Washington. In 1874 about 4,000 tons of wheat were hauled over a wooden railroad from Touchet to Wallula.

From this beginning the river barge and railroad traffic has grown to where they now haul 1.5 million tons of wheat annually. No other area of similar size in the Columbia Basin is served by such a closely woven net of railroads. Five companies, the Chicago, Milwaukee, St. Paul and Pacific; Great Northern; Northern Pacific;

Spokane, Portland and Seattle; and the Union Pacific with a total of 15 or more branch lines criss-cross the area serving the hundreds of grain elevators to which wheat is gathered for storage.

Commerce is not as important in this area as in other areas with a heavier concentration of urban population. It consists principally of the export of grain and other agricultural and forest products in exchange for manufactured goods and food items not locally grown. The area to some extent relies upon Spokane, which is just outside its boundaries, for many of its commercial activities. The amount of employment provided by various commercial activities is indicated in part in the sections on population and manufacture.

CHAPTER III

PROBLEMS

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PROBLEMS

CROPLAND PROBLEMS

Limited Basic Information and Educational Services

Generally speaking, more information on wheat production and land management is available than is being used. Dissemination of information and improvement of management techniques lag behind research until economic pressures develop a receptive attitude on the part of the farm operators. Specific areas of information are incomplete and recommendations must here be qualified pending conclusive knowledge.

While soil decline is evident, the rate and therefore the minimum essential rate of rebuilding are dependent upon continuing inquiry through the medium of soil surveys. The basic information for land classification and use planning has now been assembled for 65 percent of the cropland. The best survey to date on the remaining cropland has been of a reconnaissance nature.

Land classification depends upon soil and site surveys and can, therefore, never be more complete than the soil survey coverage. The solution for problems of crop adaptation, conservation, taxation, drainage, credit, water application, fertilization and tillage begins with land classification.

Without the background of information that enables us to cope with the various problems as they arise, surveys and land classification become a futile gesture. Research and experimentation have succeeded in pointing the way by which wheat yields may be maintained or even increased in spite of the decrease noted on many critical

areas. It is to these critical areas that attention must be given eventually for it is an accelerating process by which erosion damage is spread. If good soil can be deposited on the bottoms to their enrichment it is also possible that the poor subsoil may be spread on the bottomlands to their detriment. There is a decreasing area from which yields above present averages may be expected.

Weed, insect and plant disease control is a perennial problem likely to continue as long as agriculture is practiced. Distribution and marketing of local surplus haunt the farmer from year to year. Reconciliation of the machine and the earth has not yet been achieved. Agricultural research coupled with popular acceptance of its findings provides the greatest hope for continued prosperity for the producer and plenty for the consumer.

Mechanical ingenuity rarely fails to provide a means of doing some needed task, and agriculture provides a wide field of application. From cultivation through harvesting to crop processing the machine does a large part of the work. Its effect on soil structure is not always beneficial, however, and the downward movement of topsoil is accelerated wherever used on sloping fields. Deep tillage opens up new areas to plant roots. Basin tillage helps store water. Mulch tillage helps get the water into the soil but how they should all be combined into a cropping program which includes seed selection, fertilization, etc., is as yet unanswered.

The use of fertilizers for production is an old story. Not so old is their use to increase the nutrient quality of a crop. Even for maximum crop production every field is a problem in itself.

Endless soil testing must be correlated with continuing field tests to develop year by year plans of operation. Several laboratores are now established in the area for soil testing. Their usefulness will increase as their findings are correlated with production results, and as the history of a field evolves over a number of years' testing. Most efficient use of fertilizer on the recently open Columbia Basin irrigation project remains an unsolved enigma, the key to which can be supplied only by continued research.

Discrepancies between potential profit and actual profit indicate a lack of efficient management on many of the farms and ranches. It is reflected in the unit production cost of a bushel of wheat or a pound of beef. Management is also reflected in the decision to produce wheat or beef or potatoes, and a failure, due to controllable factors, is generally a failure of management. The efficient producer is the efficient manager, and the efficiency is made of many parts.

Factors of management may be gathered into the three general classes of informational background, financing and work efficiency. Information background includes education and current information regarding techniques, markets, economic relation of capital, labor and management costs, and records of past activities. Use of credit and the management of money are also essential to successful farming, while work efficiency depends upon attitude, health, and physical organization of the production enterprise, including use of the labor force and equipment.

Soil-Water Relationships

Water holding capacities and soil-moisture relationships vary greatly in the wide range of soil types found in this area. In the development of the new irrigated lands in Grant, Adams and Franklin counties excessive use of irrigation water on the upland areas could create drainage problems on the lower lying grounds. Yields for many crops are greatly influenced by the amount of water available in the soil. For example, yields of wheat in the dryland areas often are as low as 15 bushels per acre, whereas with plentiful moisture on the same soil types yields of over 100 bushels per acre are possible. Irrigation programming for maximum crop yields and crop quality depends upon knowledge of water requirements of various plant species under the existing natural environment. The most efficient use of natural precipitation in dryland farming requires considerable knowledge of rooting characteristics and moisture requirements of agricultural crops.

Water Erosion

The greatest erosion damage to the productive capacity of farms in this area is occurring in the Palouse and Blue Mountain foothills. On the steeper sloping lands, 10 to 15 percent have lost the topsoil. Yields on the areas with these heavy losses are less than one-half of the yields obtained where 6 inches of top soil remain.

Extremely high rates of sheet and rill erosion frequently result in this area when rapid melting of snow occurs while the ground is completely saturated or frozen, therefore, relatively impervious to infiltration. Because of its peculiar soils and topography, the Blue

Mountain foothills are susceptible to gully erosion. The Walla Walla River watershed contains many miles of actively eroding gullies.

The extensive use of fallow or the immature growth of fall sown cereal crops often leaves the land unprotected during the winter. The scarcity of well adapted and profitable non-cereal crops for the drier areas makes the devising of crop sequences to provide adequate winter cover a difficult problem.

Conversion of rapidly eroding areas to permanent sod cover has been delayed by the economic conditions favorable to highly profitable cereal production. Full utilization of forage which would result from "grain to grass" land use conversion would require fundamental changes in farm enterprises. These changes are very difficult to accomplish.

Erosion, similar to but less severe than that in the Palouse, is encountered in the Big Bend dry farming section of this area where grain and fallow have been alternated in the cropping systems. This fallow area normally receives less precipitation, and its topography is generally more favorable than that of the Palouse area.

Significant damage to the area's irrigated croplands results or will result from improper water application methods and practices. This problem will be discussed further under irrigation in this report.

The erosion of stream banks in this area is of spectacular proportions on a few widely scattered streams. The most extensive loss through this type of erosion is found along the Touchet River in southeastern Washington, but is severe on Pataha, Deadman, Willow, Mud and Rebel Flat Creeks, particularly in the spring of the year when the snow is melting. The greatest amount of gullying seems to occur in the 10-12 inch precipitation zone.

Wind Erosion

Wind erosion is a major problem of both irrigated and non-irrigated lands of the Big Bend area. Soil drifting occurs on the sandier soils of this area during the spring windy season when extensive cultivation for seed bed preparation is in progress. During cycles of low precipitation this area is very vulnerable to wind erosion.

With the development of new irrigated lands in Grant, Adams, and Franklin counties, extensive losses occur due to wind erosion. In recent years wind erosion in this area has been primarily due to the breaking up of new lands being placed under irrigation. Because of economic conditions and the demand for cash crops such as beans, potatoes and other row crops, wind erosion will not be confined to the first year the land is being irrigated.

Declining Soil Fertility

Deficiency of Plant Nutrients

In the irrigated sections of this area most of the soils are naturally low in organic matter content. Low organic matter content, contributes to the problem of unsatisfactory soil structure, and reduces the water holding capacity of the soil. In the Palouse and Big Bend dry farming areas, a high percentage of organic matter of the virgin soil has been lost by erosion and over-cultivation. Poor soil structures, which are often the cause of inadequate water infiltration into the soil, and poor soil aeration are serious problems that threaten all except the coarse sandy soils.

Nitrogen, being closely associated with organic matter, is generally low in the soils of this area. The nitrogen content of a

surface foot of soil in irrigated lands in this area range from 1,000 to 2,000 pounds per acre. Experiments show that no more than 20 to 30 pounds of nitrogen per acre is made available annually. Considerably larger amounts are necessary to maintain and produce good crop yields. Hence, the original nitrogen in the soil is not too important for the major part required by crops must be supplied by additions of nitrogen fertilizers or by growing leguminous crops previous to the production of non-leguminous crops.

In the dryland farming areas, where the annual precipitation exceeds 16 inches, available nitrogen is generally deficient for maximum yields of wheat. Annual cropping is being extended into this zone by the use of nitrogen fertilizer.

In the dryland areas of the Palouse and Big Bend phosphorus currently is not a problem. In the old irrigated sections of Douglas and Walla Walla counties periodic applications of phosphate fertilizers are needed for the maximum yields of the majority of the crops grown.

In the new irrigated sections phosphate has been used in the establishment of legume crops with satisfactory results. As more of this area is developed and as other parts have been under irrigation for a longer period of time, phosphate needs will undoubtedly increase.

Experimentation has shown that in the foothills area in the Blue Mountains a response has been obtained by the addition of sulphur to cereal crops. The use of sulphur on dry legumes is more widely spread in this area.

Deficiencies in available potassium do not occur in this area. However, with more intensive cropping and additional years of farming,

it is expected that more soils will be affected and potassium deficiencies will become more acute.

In recent years, boron and zinc deficiencies have been detected in the irrigated soils of this area. The application of zinc has proven successful, particularly on bean crops.

Soil Deterioration

Salt and alkali conditions result in a large part from inadequate drainage and are the direct cause of partial to complete crop failure on affected soils.

Approximately 20,000 acres of land in the Big Bend-Palouse-Lower Snake area are alkaline or alkali-saline in varying degrees. Much of the alkali soils in this area are formed in "pot hole" areas which are so situated that the spring runoff from snow and rain collects in small ponds with no natural outlet.

The balance of the alkali soils is found on some of the deep, poorly drained bottom land soils. At the present time the major portion of this land is being used for pasture. The alkali condition has lowered the productivity of some areas to the point that they will produce only a cover of salt grass and the more alkali tolerant grasses. The middle Walla Walla Valley and Alkali Flat Creek are examples of land damage by alkali or salt accumulation. This problem might develop on land under irrigation if adequate drainage is not provided.

The major problem of soil toxicity results from arsenic accumulation in the soil and is confined largely to apple and pear orchards of the old irrigated sections of southern Walla Walla, Umatilla and

Douglas counties which have received repeated applications of arsenical compounds over a period of years.

Drainage

The amount and seasonal distribution of natural precipitation or the availability of irrigation water are important in determining the type of agricultural crops grown in any area. Insufficient water or too much water both are problems, and in order to achieve wise management of water resources, there is need for a better understanding of the relationship of moisture to soil and plants.

Inadequate drainage is a problem of the wetter east side of the area and of the irrigated sections. Drainage problems outside the irrigated areas and the humid belt are confined primarily to the potholes of the Cow Creek and Crab Creek watersheds. There is a definite need for greater anticipation of drainage problems and advanced planning to take care of problems when they arise in the development of new irrigated lands.

The design of suitable drainage improvements for arid irrigated lands usually requires an intensive investigation of the subsoils and underlying strata to ascertain the source and behavior of underground water and to determine the best methods of control. Without adequate drainage it is conceivable that in many instances the value of lands lost to production because of the accumulation of alkali may greatly exceed the value of land gained through the irrigation of poorer upland soils. Future prosperity of the newly irrigated lands will depend largely upon solution of the related drainage problems.

Irrigation

On the old irrigated lands of Walla Walla and Douglas counties insufficient supplies of irrigation water have not occurred recently. In Adams, Grant and Franklin Counties where irrigation is now being developed, a shortage of irrigation water is not anticipated. The elimination of unnecessary waste of irrigation water is a problem of major importance because of its effect on drainage and waste of electric energy used for pumping. In areas where irrigation waters are supplied by diversions from streams, water conservation is definitely a problem. Frequently the low seasonal flows coincide with the periods of peak irrigation requirements.

Improvement in irrigation will usually go hand in hand with improvement in irrigation systems. Much of the inefficiency in water application can be attributed directly to improper and inadequate design and construction of the farm irrigation system. Important factors in efficient water use on farms are: (1) scientifically designed, well constructed and skillfully operated water distribution facilities to serve properly prepared fields; (2) the use of an irrigation method adapted to specific conditions. Moisture holding capacities of soils, water intake rates, water requirements and root zone depths of crops all have an important influence on the frequency of irrigation, rate of application and amount of water required.

Irrigation Erosion and Leaching

Planting and cultivating operations are facilitated and irrigation labor costs sometimes are reduced through the use of long irrigation runs. The longer the run, the larger the stream that must be

introduced at the supply end of the furrow; the larger the stream, the greater its power to pick up and transport soil. Many farmers are causing damage to their land by the continued use of poorly adapted methods of irrigating or improper use of a well adapted method. One of the major problems in the development of the new irrigated lands will be to provide sufficient technical assistance to farmers to encourage them to install and operate properly the new system.

Soil erosion rates of more than 80 tons per acre per year have occurred in corn fields irrigated by furrows on 2% slopes. Although small grain and other close growing crops are less susceptible to erosion, soil loss rates as high as 35 tons per acre per year for small grain and 15 tons per acre per year for new alfalfa are common when inappropriate irrigation practices are used on sloping fields. Some of the irrigation project lands in Grant, Adams and Franklin counties have slopes from 4 to 12 percent. Soil losses could become serious in a short time on these soils.

Crop Enemies

Weeds

The cropland sections of this area are threatened by numerous weeds spreading through the area and causing loss in crops and livestock. Crop production cannot be maintained or increased unless weeds are brought under control. The weed problem is generally more severe in the Palouse and Blue Mountain foothills area than it is in the Big Bend dryland farming areas. Weeds are most prolific where annual precipitation exceeds 15 inches.

Harmful weeds that cause considerable damage to croplands are: Blue-flowering lettuce, Canada thistle, morning glory or bindweed, leafy spurge, Russian knapweed, whitetop, poverty weed, and Dalmatian toadflax. These plants also grow well in the non-cropland areas which serve as a source of reinfestation for cropland. Along rights-of-way, many weeds are disseminated by the transportation of cargoes infested by weed seed. Waterways, particularly in irrigated areas, serve as a means of spreading seeds of noxious weeds growing along the banks. In the irrigated sections, aquatic weeds often interfere with the delivery of irrigation water. They also consume water intended for crop use. One of the major sources of weed infestations is the use of weed contaminated crop seeds.

Plant Diseases

There are many different plant diseases affecting commercial production of crops in this area. Wheat smut and snow mold are two diseases of primary importance to the cereal production areas of the Palouse and Blue Mountain foothills and Big Bend.

It is difficult to predict the disease problems most likely to occur in the new irrigated lands because so many factors can change and new diseases are always a threat. Susceptible crops and the diseases likely to occur are:

Alfalfa:	Bacterial wilt
Beans:	Curly top, root rot, sclerotinie rot, blight
Clover:	Powdery mildew
Potatoes:	Leaf roll, scab, wilt diseases, ring rot, blight
Tomatoes and garden vegetables:	Curly top

Stone fruits: Numerous virus diseases, powdery mildew

Pome fruits: Fire blight, mildew

Insects

Insect pollinators are highly essential in the production of many of our agricultural crops. These include the honey bee and numerous wild bees. These should be protected from poisonous insecticides and their nesting areas preserved or encouraged. Insect predators and parasites should be given an opportunity to multiply. Use of certain poisonous insecticides at times has had harmful effects on the honey bee, wild bee, and predators and parasites of insects. Nesting areas of wild bees have been destroyed.

Insects adversely affect our agricultural economy in many ways. They may be native to the locality or imported into it on planting stock or by automobiles, freight cars, aircraft or busses. They arrive by migration on the prevailing winds. They may arrive on imported farm produce, poultry and animals, hay and straw, empty crates and boxes. With very little encouragement many become permanent residents instead of temporary guests.

Some act as carriers of serious diseases of plants, animals and man. Others may cause injury either by their direct feeding or as contaminants of produce intended for food. Many insects attack specific crops or feed in specific zones. Soil insects like the wire worm menatodes and root maggots feed on roots and tubers underground. Some, like the cutworm, live in the soil but feed on the surface, while others attack the leaves and stem in various ways.

Insect losses will vary with any particular crop. Certain general plant feeders, such as wireworm, aphids, grasshoppers, cutworms, thrips, and mites attack a wide range of host plants.

The following list of crops and their insect pests is not complete, but indicates the extent of the insect problem:

Crop	Insects Attacking Crop
Alfalfa	Wireworm, spider mite, lygus bug
Apples	Codling moth, spider mites
Asparagus	Asparagus beetle
Cherries	Cherry fruit fly
Coles	Cabbage maggot, aphids
Forage and grain	Grasshoppers, Mormon crickets
Onions	Onion thrip, onion maggot
Peas	Pea weevil, pea aphid
Potatoes	Wireworm, nematode
Sugar beets	Wireworm, leaf hopper

Rodents and Rabbits

Some of the many injurious rodent species found in the area are rats, mice, gophers, ground squirrels and woodchucks. Rabbits, although not classified as rodents, are also included in this discussion.

Rats are the most serious menace as they act as carriers of human disease, kill poultry and livestock, and destroy huge quantities of foodstuffs. It has been estimated that 30 rats will eat or waste enough rations to feed a dairy cow.

Other rodents cause damage in many ways. Rabbits and mice damage all crops, including orchards. Ground squirrels reduce available

pasture forage materially, and many species will devour vegetables in the field or in storage. Muskrats, field mice, squirrels and pocket gophers cause trouble in irrigated areas by burrowing into ditch banks or levees. Field mice can contaminate select varieties of seed crops by carrying seed from one field to another.

Credit

The use of borrowed funds is an accepted part of normal business management applicable to farms as well as industry. The use or non-use of credit will have long-time repercussions on the level of living of a farm family. A correct solution of the problem of when and how much to borrow frequently makes the difference between economic slavery and a successful enterprise.

Development of the Columbia Basin irrigation project creates a new and expanding field for credit in land development, building construction, and equipment purchase. These must be relatively long-term loans and therefore require stability and reliability on the part of both borrower and lender. In general, this type of credit is not readily available except for a limited amount of financing by the Farmers Home Administration.

Many types of credit, ranging from private individuals to the Federal Land Bank are available to established farmers in the area. The problem is more the establishment of a credit rating and how to use credit once it becomes available. Best use becomes a problem of long time farm planning based on as complete information as possible regarding production capacity, markets, costs of operation, and management technique.

In addition to private sources and the Federal Land Bank there are commercial banks, life insurance companies, the Farmers Home Administration and Production Credit Association. Each agency has its specialty but many overlap and the prospective borrower may investigate to determine the most favorable financing arrangements.

Miscellaneous Farm Problems

Social, domestic and marketing problems not directly tied to farm production are of special importance in the Columbia Basin irrigation project. Few telephones are available to the new farms and road construction falls short of keeping up with the expansion of settlement. To most of the settlers land development is of higher priority than home construction or domestic water supply.

Domestic water is difficult to obtain from the underlying basalt and is too much of a financial undertaking for each settler to develop individually. The type of farm enterprise depends on availability of year-round water. Livestock and poultry require water every day of the year and cannot depend upon canal flow except during the irrigation season.

The area is well supplied with arterial highways but the farm roads require extension to new farmsteads. Abundant rail service is available from a half dozen lines crisscrossing the land from Spokane to Walla Walla to Pasco and Ephrata.

Because of comparative isolation from metropolitan and industrial areas marketing costs are high. Farm products must be shipped from 100 to 3,000 miles with the consequent handicap of high transportation and handling costs.

In the case of wheat, the main crop of the area, storage lack occassionally causes considerable loss when harvest is at its peak. Wheat is frequently piled on the ground awaiting shipment to terminal storage principally located at Portland.

Marketing problems at some time plague the producer of any farm commodity but they hit most often the fruit and vegetable producer. Apples, prunes, peaches, pears, lettuce, carrots, tomatoes, onions, potatoes and melons have all suffered from drastic fluctuations in price from season to season. Local surpluses pile up; poor quality and low grade products sometimes flood the markets; or frost kills the developing crop causing a shortage.

Lack of information on world, national and local production creates problems of management to the extent that it affects decisions on seasonal cropping plans. Intelligent adjustment of cash crop and livestock feeding depends upon access to accurate information.

Tenure

For the entire area 24 percent of the farms are operated by tenants and 32 percent are operated by part-owners. Part-owners own part of the unit they operate and rent part. Tenancy is concentrated in several counties, including Adams County with 41 percent tenancy and Garfield County with 42.5 percent.

Tenancy arises in this area largely because of the high capital requirements for operating an economic unit. In Adams County, for example, the average value of farm and buildings as reported in the census was $105,000 per farm in 1950 and in Garfield County $89,000

per farm. These figures do not include the capital required for farm equipment.

Livestock operators have failed to utilize grass grown in crop rotations and green manure crops largely because of unsatisfactory lease arrangements and lack of equitable rentals.

RANGE PROBLEMS

Problems on vast areas of range are serious from the standpoint of the welfare of the Big Bend-Palouse-Lower Snake area. Its ranges fall far short of potential production which present intensity and character of grazing use will not sustain. Plant cover is not satisfactory from the standpoint of watershed protection, and the present use of the forage is not always consistent with other uses of the land.

The importance of problems of the range is illustrated by the fact that range forage, as a crop, is produced on nearly 50 percent of the land acreage in the area. Forage on the 3,750,000 acres of nonforest range, exclusive of the rangeland which will be converted to irrigated cropland under the Columbia Basin Irrigation Project and the majority of the 140,000 acres of forested range, provides the foundation upon which is built the extremely important range livestock industry. Nearly one-half of the total forage and feed consumed by beef animals, sheep and horses of this area is range forage. In addition, these ranges plus about 202,000 acres of forested land not grazed by domestic livestock furnish the forage for approximately 45,000 deer, 11,000 elk and 300 bear.

General problems of the range arise from many factors. There are those associated with the present conditions of the ranges due to the intensity and character of grazing use by livestock and big game. There are problems associated with the present ownership, occupancy and financing. Problems also have resulted from the more recent endeavor to correlate grazing use with other uses of the land, and from the lack of knowledge regarding the ranges of this area.

Problems Resulting from Present Range Characteristics

Present Deteriorated Condition of the Range

In the early part of the 19th century, Fort Walla Walla was established at the junction of the Walla Walla and Columbia Rivers. Livestock operations developed from there and from the north by way of Montana and Idaho. The broad, open lands of central Washington, with their bunchgrasses, offered an easy method of raising cattle and sheep with a minimum of winter feeding, as a rule. From 1860 to 1881 cattle and sheep raising dominated the area, but with the advent of extensive farming operations on the rich loessial prairie soils of the Walla Walla and Palouse regions, livestock became of second importance in financial returns to grain farming.

During the 80 or 90 years of grazing use by livestock, ranges in the area have been altered in forage productivity and soil stability, often with serious consequences to watersheds, the range livestock industry, and to the economy of the area.

The present forage production on range grazed by livestock is estimated as enough to carry 990,000 animal-unit months of use. Large as this seems, the estimated production is less than 50 percent

of what it once was. Nearly 75 percent of all ranges are not producing to capacity. Some have deteriorated to such an extent that they are producing less than 10 percent of their original yield. Overgrazing, poor management, drought, recurrent fire, rodent and insect damage are responsible.

No less important than the much lowered forage productivity on these deteriorated ranges are the impaired water relations. The inferior plant cover, both living and litter, does not promote maximum water infiltration and retention. Runoff and erosion, in many instances, are excessive.

On much of the 1,761,000 acres of range in poor condition, the desirable native forage plants are all or nearly all killed out. Natural revegetation of the desirable plants, even under the most favorable management, requires a long period of time. Such a delay, in view of the pressure for additional forage production for livestock, may be uneconomic. Moreover, further declines in soil productivity may occur in the meantime, and the hazards of flood and sediment continue on high value watersheds.

Other activities on the range, such as harvest of timber, road and power line construction, and fire, expose the soil and kill out good forage plants on many acres each year. It is estimated that logging operations on grazed forest land reduce the grazing capacity by 25 to 35 percent in that area. However, grazing capacity returns to within 10 to 15 percent of normal within a few years. On these ranges where soil is exposed danger of invasion by poisonous or undesirable plants such as St. Johnswort in Whitman, Latah, Garfield,

Columbia and eastern Walla Walla counties; or sagebrush and cheatgrass in the west will remain high until a satisfactory plant cover is restored.

Severe erosion presents a serious problem on some ranges. In some portions of Walla Walla, Columbia and Garfield counties where the snow and runoff are heavy, highly productive mountain meadows and bottomlands have been deeply incised by gullies as much as 20 feet deep. This lowers the water table, and makes it impossible to restore forage production on these highly productive sites to full capacity without restoration of the water table. In other range areas, especially on the lighter sandy soils along the Columbia River in western Walla Walla, Franklin, and southern Grant counties, past overgrazing, recurrent fire, and attempts at cultivation have initiated severe wind erosion and often started sand dunes. This greatly lowers productivity of the immediate area as well as being a threat to adjacent range. On some ranges, especially along stock trails and ridgetops in the Blue Mountains of Columbia and Garfield counties, erosion has proceeded so far that all of the top soil is gone. Erosion still continues and infiltration capacities of the soil are undesirably low. On still other ranges, such as the sandy bench terrace areas in Columbia, Garfield, Walla Walla and western Douglas counties, the soils have become unstable and are subject to damaging storm runoff or wind erosion.

Noxious and Undesirable Plants

Infestations of noxious and poisonous plants and overly dense stands of undesirable plants rob the range of the area in many ways.

Some plants, like big sagebrush and rabbitbrush, are relatively unpalatable and obstruct revegetation and use. Some, like water hemlock, are poisonous and cause livestock loss, so serious in some cases that livestock must be taken off the range. Some, like Canada thistle and morning-glory in the eastern portion of the area and whitetop and Russian knapweed along moist bottomlands, are a constant threat to adjacent cultivated lands; and one such as St. Johnswort in Whitman, Latah, Columbia and Garfield counties, spreads rapidly, invades depleted ranges, and renders range valueless. Nearly all of these plants may occupy sites to almost complete exclusion of desirable plants, produce little forage in return, and form a barrier to the return of desirable plants.

Noxious and poisonous plants are a problem on 500,000 acres of range in the area. In addition, it is estimated that there are 1,580,000 acres covered by dense stands of such undesirable range plants as sagebrush, cheatgrass, and rabbitbrush.

The presence of these extensive acreages of noxious and undesirable range weeds is a major problem in the protection and full utilization of grazing lands of this area.

Rodents and Rabbits

Rodent damage to forage, although widely distributed, is not present in great enough intensity to be a serious menace, or a major contributing cause of presently poor condition ranges. Tributary watersheds show some forage loss by jack rabbits in scattered areas, causing delay in recovery after the forage is grazed down by livestock.

In addition to jack rabbits, which are widely dispersed over the area, local populations of pocket gophers, ground squirrels, and field mice are found. Approximately 30,000 acres are infested with gophers and ground squirrels to an extent that seriously reduces the amount of forage available to livestock and game. There is no evidence of cycles or annual variation in occurrence of rodent numbers insofar as harmful effects on range forage may be an indicator.

Insects and Plant Disease

Most of the insect damage to grazing areas is due to the periodic infestations of grasshoppers. They also spread from range nesting grounds onto adjacent cropland when food becomes scarce. In a similar manner occasional plagues of Mormon crickets attack areas in western Grant, Adams and Franklin counties. Grasshoppers appear in limited numbers throughout the area but are periodically most damaging in the 8 to 10 inch precipitation zone.

Such insects as the aphids, leaf hoppers and lygus bugs maintain a more or less constant population but are not usually a serious problem of range production.

Of the insects that attack livestock the horse bot and cattle grub are probably the most serious. Less damaging but annoying are the sheep bots, sheep keds, mosquitoes, horse flies and horn flies. They are all found to some extent wherever there are livestock.

Epidemics of disease such as smut, root rot and blight have, likewise, caused damage to the range, often local in extent but nevertheless of importance. There are many diseases attacking the roots, foliage, flowers and seed. These generally have not received much

attention on range lands, unless, as in the case of smut, they cover large acreages. Smut attacks on cheatgrass may reduce the production of cheatgrass to almost nothing. Such damage in localized areas has occurred from other diseases.

Insects and disease, even though not serious by themselves may, when in combination with weakened plants as a result of drought or overgrazing, cause complete loss of many of the more desirable forage plants.

Accidental or Uncontrolled Fire

An annually burned area of approximately 25,000 acres of forested and non-forested range land in the Big Bend-Palouse-Lower Snake area has far reaching consequences on the range conditions and forage production in some of the more depleted sections of the range area. The immediate result is an estimated annual loss of 4,000 to 5,000 animal-unit months grazing capacity with only about 200 animal-unit months of this loss on public range. Of even greater importance, however, is the weakening or killing of desirable grasses and shrubs, destruction of the litter, and acceleration of soil deterioration and erosion. On perennial bunchgrass ranges, the danger lies, not so much in the burning of the grass itself, but in the faulty management practices that are often used on the fire-scarred area the spring following the fire. Food stored in the grass roots promotes a vigorous, green growth in the spring, and as there is no protection from the old stems which have been burned, stock can keep the grass chewed down to the ground level. This practice results in little or

no food storage in the roots for the coming season, weakening of the plant, and its eventual death in many cases.

The annual loss from fire is especially high on spring-fall ranges of sagebrush and annual cheatgrass in Grant, Adams, western Franklin, and western Walla Walla counties. Here it is estimated that the incidence of accidental fire is 500 times greater than where perennials form the dominant part of the plant cover. Fires started in cheatgrass ranges often gain such momentum that they are extremely difficult to stop with standard fire-fighting equipment. A further complication is that natural or artificial revegetation in cheatgrass types is nullified by recurrent fire; new perennial seedlings, with their weak root systems during the first few years are easily killed by fire. Added to these problems are the increased acuteness of soil deterioration, erosion, and flood hazard.

Problems of Present Grazing Use

Intensity and character of present grazing use--harvest of the annual forage crop by livestock and big game--create many problems on the range lands of the Big Bend-Palouse-Lower Snake area. In some locations, such as portions of the perennial grass and sagebrush types in Douglas, Grant, Adams, Franklin, and western Walla Walla counties, ranges are grazed by livestock only. In others, such as Latah County and the fringes of the forested areas of the Blue Mountains in Garfield, Columbia and Walla Walla counties livestock and big game graze the range.

A downward trend in the productivity of the range as a result of grazing use is not nearly so general now as it was 30 or 40 years

ago. Many ranges in public and private ownership have been improving during the last 15 to 20 years. The downward trend is still, however, apparent on some ranges as a result of overgrazing, rodent damage, and uncontrolled fire.

Even though the present situation appears much improved recently there has been a sharp buildup in beef cattle numbers as a result of high prices and high income taxes. Big game numbers, especially in Columbia and Garfield counties, have continued to increase. Moreover, there has been and will continue to be a great decrease in the total acreage of range.

Nearly half a million acres of grazing land will be converted to cropland use under the Bureau of Reclamation's Columbia Basin Irrigation Project during the next 20 years; some additional land has been plowed up for dry-farm wheat production. These decreases in range without a corresponding decrease in grazing animals, forecast a reversal of trend on many private and some public ranges.

Downward trend, or deterioration in range condition, not only means a decrease directly in forage production through damage to the plants, but it means an indirect decline in forage productivity as a result of loss of soil moisture. Increased runoff, and loss in soil productivity as a result of erosion, loss in organic matter, and a general deterioration of growth conditions all follow in rapid succession once the land cover is depleted by overgrazing.

Imbalance of Livestock Numbers and Forage Production

Imbalance of livestock numbers and forage production is one of the most pressing problems faced. The situation where too many

livestock are being grazed is by no means uniform, because many ranges are properly stocked. Some are severely overstocked with sheep or cattle and in a few areas with horses which the farm operator has retained from grain-farming operations before these horses were replaced with tractors. Part of this overstocking has come about as a result of the recent increases in numbers of beef cattle on the range without an accompanying increase in forage production; part of it is the result of long-time failure to balance livestock numbers with forage production.

Overstocking of the range, especially in the drier western portion of this area and in the timbered foothill areas of Walla Walla, Garfield, and Columbia counties, is having serious consequences on the range through excessive utilization of the current production of the desirable forage plants. It is futile to try to improve range lands through superior grazing systems, extensive water developments, fences, plant or rodent control, or other measures unless the livestock are in balance with forage production.

Difficulties in ease and rapidity of determining grazing capacity form a major problem in balancing livestock numbers with forage production. There is no definite accepted manner for arriving at grazing capacity that can be quickly applied. Present methods give a preliminary estimate which must be confirmed or altered by careful follow up on utilization of the forage and trend of the range.

In establishing safe levels of grazing use for all types of range within the area, variations in forage production from year to year must be taken into account. Yearly forage yields vary markedly

due to annual variations in precipitation, temperature, and other climatic factors. Other factors such as rodent, insect and disease damage must also be taken into account.

Improper Seasonal Use

Improper seasonal use and imbalances of seasonal ranges are serious in portions of this area. In the drier western area, there is a lack of summer range, and livestock are often kept in the same pasture units of spring-fall type range for excessively long periods of time. When adequate rest periods are not provided for the desirable forage plants during the active growing season, the range deteriorates by the elimination of these plants.

In the foothill areas of Walla Walla, Columbia, Garfield, and Whitman counties, there is a serious lack of spring-fall range, and livestock are turned on the range from the winter feedlots too early. Normal growth of the plants is seriously handicapped by continuous grazing or by grazing when the soils are too wet. The result is serious damage to both forage plants from grazing and to soil from trampling.

The major stumbling block to proper seasonal use is the serious unbalance in seasonal ranges that occurs in various parts of the area. It is estimated that there is only about one-fourth as much grazing capacity on ranges suitable for summer use as there is spring and fall range. This means that many cattle and sheep stay on typical spring-fall range all during the summer or that portions of the summer range are grazed much too heavily. Damage to the plants, infestation by noxious and poisonous plants, low calf and lamb crops, or low livestock gains result.

Inadequate usage is being made of grass grown in crop rotations and of green manure crops in the eastern portion of the area. Unsatisfactory lease arrangements and lack of equitable rental rates are primarily responsible for failure to utilize these forage resources in the yearlong livestock operation. In addition, the farmer's fear of the spreading of weed seeds in his fields, and the livestock operator's lack of cooperation on the leased land have hindered development of efficient use for these crop rotations.

Part of the failure to delay grazing each year until plant growth and soil are ready arises from the wide variation from year to year in the date that the range is ready for grazing. The season for beginning grazing use will vary as much as a month. These variations require more feed reserve than is needed in the average year, and careful coordination of livestock operations with the amounts of different seasonal ranges.

Distribution of Grazing Use on Range

Lack of uniform distribution of grazing use is an important and difficult problem on most of the ranges of this area. Distribution of use is generally unsatisfactory, even on more level range, but it is especially poor on ranges with steeper topography or forested and grassland types intermixed. Some parts of the range pastures or allotments are grazed too heavily and some not enough. This lack of uniformity is the result of inadequate physical improvements, such as fences and water developments, and poor handling of livestock. Range management activities are far from adequate on many ranges.

The most important problem in sheep management is obtaining trained and experienced herders. Sheep enterprise operators have difficulty finding such men.

Cattle on range get the minimum of herding which encourages bunching near waterholes and on the more accessible range. Moreover, proper location of salt grounds to draw cattle into less used portions of the range has not been sufficiently used.

Fencing to break range pastures or allotments up into managerial units and fences to divide allotments on public land are not nearly as widespread as needed.

On most of the spring-fall range, especially in the drier western part and the more rugged parts of Walla Walla, Columbia, Garfield, Whitman and Latah counties, number and distribution of stock watering places are unsatisfactory. As a result, there is a concentration of grazing use near the existing watering places, and light or no use two or three miles away.

The lack of stock trails along the steep Snake River breaks in Franklin, Whitman, Walla Walla, Columbia and Garfield counties and along the Columbia River in Grant, Douglas, and Lincoln counties, is contributing to poor distribution of grazing use on some of these steeper lands.

Integration of Use on Public and Private Ranges

Failure to integrate use on public and private ranges in certain parts of the area has created a few localized problems in grazing management. It is often difficult to work out proper management with the variety of ownerships peculiar to the area. In another instance,

farm and ranch operators adjacent to the Blue Mountains have run their livestock on the rugged drainages of the Walla Walla, Touchet, and Tucannon Rivers for many years with little or no supplemental cultivated pasture on their own lands.

Big Game Grazing Management

Game census figures serve best to show trends from year to year. Though game census-taking is difficult and the results often inadequate, the reliability of results has been improved by the use of airplanes and helicopters which permit increased areal coverage. Because of increased hunting in recent years, the elk population is more or less constant. The deer population, however, is increasing greatly. Some fluctuations in deer population are caused by heavy winter kill during periods of extreme cold or unusually deep snow. Hunter success is fair, though it accounts for only ten percent of the game census estimate of big game population. There is resistance by certain sportsmen's groups to reduction of the game herds; but there is considerable pressure from farmers for further reductions.

Though hunting pressure is increasing, it is limited to areas of easy access. Use of jeeps and power-wagons on open slopes and on roads adequately "winterized" has led to severe gullying in many places.

A major problem has been inadequate correlation between the land management and the game management agencies, each with its own objectives. Land owners and land managers have little influence on game management, even though the game populations may have serious adverse effects on land management.

Seasonal movement of game is difficult to control, even by distribution of salt or by provision of watering places. Game animals follow the forage supply. For elk, there is too little summer range compared with the amount of available winter range; and in open winters some of the summer range is used yearlong. A resident non-migratory deer population has built up on the winter range at low elevations along the breaks of the Snake River and tributary draws with stringers of timber or brush cover. The shortage of winter range for these resident deer populations, and for elk in some areas, leads to extensive cropland damage. The animals break down fences, eat the crops, browse the orchards, and trample the soil when it is wet.

Game and livestock both graze over much of the same area. Elk and cattle feed on the same grass species; bluebunch wheatgrass, Sandberg bluegrass and Idaho fescue. Combined game and stock grazing long ago eradicated green fescue, a desirable perennial, from the range in this area. Elk, cattle and sheep browse the same brush species: The huckleberry, elderberry, Menziesia, willow, and bitter cherry. The willow and cherry are now practically eliminated.

The problem of overlapping use by both game and livestock is serious on perhaps fifteen percent of the range area at present. There has been a great reduction in sheep grazing; and the increase in cattle grazing has been principally on irrigated pasture below the range. In fringe areas, winter range for game is used by livestock in spring and fall. Game needs for forage have not been sufficiently considered in setting grazing capacities for livestock, with consequent overuse of forage and damage to the range.

Problems of Correlation with other Uses

The production of forage for livestock and big game use is but one of the major uses of the range in the Big Bend-Palouse-Lower Snake area. In the eastern portion of the area the headwaters of the Palouse, Tucannon, Touchet, and Walla Walla Rivers have high watershed values and produce timber for local industrial and home use. There are scenic and recreational values in the Blue Mountains, Cheny Lake area, and along the length of the Columbia River to the west. The Grand Coulee valley was once the bed of the Columbia River. It will now be used in conjunction with Grand Coulee Dam as an equalizing reservoir from which will stem the main irrigation canals for the million acre Columbia Basin project. Some of these other uses in several localities far transcends in value that of the forage produced.

In the general consideration of ranges for forage production and other uses, there has been an almost complete lack of land classification and of planned correlation of uses. There has also been little appreciation of interrelationships between uses.

Forage and Water

Past utilization of the forage by livestock and big game, in the majority of cases, has not been such as to maintain plant cover and soil conditions that were conducive to maximum yields of usable water, as well as to the production of desirable forage crops. Elk congregate along the receding snowline in the spring, trample the soil, and graze too heavily on the early grass growth. Resulting soil compaction and sparse cover leaves a wide zone subject to rapid

runoff and severe erosion. In the Walla Walla River area, this process has contributed to deterioration of water quality for municipal use and to channel sedimentation and increasingly destructive flooding.

Excessive use of meadows by grazing animals has had similar results, destroying the plant cover and compacting the soil. Trailing by large numbers of animals on the slopes cuts new channels, and also leads to severe gullying. As a result of abuse of the soil and plant cover, runoff does not occur as clear flowing spring discharges. Rate of infiltration has been decreased, amount of runoff increased, and serious erosion has taken place. Siltation of reservoirs and irrigation structures, changes in stream channels, and downstream flood damages have resulted.

The situation is improving somewhat and there are many tracts of range where management is conducive to the production of both forage and clean water. A stable soil and a satisfactory plant and litter cover to take in and store water are being maintained. Many individual ranchers and the two national forests in the area have developed and put to work better plans for forage and watershed management. The town of Walla Walla has withdrawn from other use a large acreage of the Mill Creek watershed, for its domestic water supply. Downstream irrigation districts and individuals are becoming increasingly active in the promotion of better upstream management.

There are, however, some ranges where present utilization of the forage crop is too heavy or too early, and unfavorable watershed conditions are being maintained or are increasing in seriousness.

Moreover, there are some ranges where soils are so light and unstable, or slopes so steep, that any grazing use may be damaging to watershed values.

Forage and Timber

In seasons of deep snow, yarding of deer leads to heavy damage to young trees. This is usually a problem only locally. Overgrazing on the forested lands removes the brush competition, bares the mineral soil, and permits dense "jungles" of tree reproduction to come in. Growth in these jungles is stagnated, and timber yield is reduced. At the same time, forage production is greatly reduced.

Disturbance of the soil by the timber harvest may cut forage density from 25 to 40 percent for the first year after logging. In three or four years, the forage density may become even greater than originally, but involving a change in species with more weeds and less grass. Generally, logging damage reduces carrying capacity for grazing 10 to 15 percent.

Forage and other Competing Uses

Proper use of the forage by livestock and big game has no serious effect on upland birds nor on furbearers; but overgrazing spoils the habitat and drives the smaller animals out.

There need be no conflict between grazing use and recreation, even on those ranges where recreational values are high, yet campgrounds are sometimes damaged by livestock.

Some range problems accompany recreational use. Overgrazing by horses around campgrounds and along trails may grub out all available forage. Erosion starting from heavily used trails may damage adjacent

range lands unless the trails are well maintained and properly drained.

At the present time, there are no conflicts between grazing and mineral values in this area. In times past, gold-dredging in some of the stream bottoms and meadows completely ruined the highest capacity grazing land for further use.

Management of range lands may affect the value of adjacent croplands. The croplands afford a summer forage supplement that permits the ranchers to use their winter range more efficiently. Watershed damage from improper range use leads to sedimentation that interferes with irrigation; and may also lead to flash floods that damage farm lands below.

Adjacent to locations where sugar beets, tomatoes, and other truck crops are grown, range land condition affects the abundance of the beet leafhopper. Annual weeds and the perennial sagebrush that invade heavily used and depleted ranges provide alternate hosts for the leafhopper, and permit it to build up populations that can cause heavy damage to crops nearby. The original range cover does not include plants that are favored hosts of the leafhopper.

Problems of Range Tenure and Financing

The historical development of agriculture in the Big Bend-Palouse-Lower Snake area, and the policy for disposal of public lands during the early developmental period has followed the same general trend as in other arid areas. The original Homestead Act of 1862 allowed 160 acres to be filed for a homestead; and in 1916 the Stock-raising Act increased this to 640 acres. For the more humid areas

of Walla Walla, Columbia, Garfield, Whitman, Latah, Spokane and Lincoln counties, a section made an economic unit and most of the land was homesteaded. In the drier western part, it was impossible to make a living on the same acreage and much of the land was left in public domain. To further complicate the ownership pattern, large grants of land, of every other section in Grant and Franklin counties, were given to the railroads. The result of these policies is a "crazy-quilt" pattern of small private, public, and large corporation, ownership introducing many problems regarding tenure that have a profound effect upon management, use and rehabilitation of range lands.

Size of Ownership Unit

Throughout the grazing lands of the area, size of individual ownerships varies widely from the many small, marginal units along the foothills in the east, to several extremely large ownerships in the central and western parts of the area. Small and extremely large ownerships are less stable than the medium-sized ownerships, and there are usually lower rates of return. Some of the larger sheep enterprises that once wintered in Franklin and Grant counties went bankrupt years ago. Many of the other 160 and 640 acre homesteads of the drier western area have been bought up and consolidated with the larger operations. Many of the small submarginal units along the foothills have cleared more steep land and have remained due to favorable grain prices. What livestock was owned has been concentrated on fewer range acres with the resultant increased range deterioration.

Pattern of Land Ownership

The pattern of range ownership is characterized by scattered tracts of private land in resident and absentee ownership, interspersed with blocks and scattered tracts of land in Federal ownership under the jurisdiction of several departments or bureaus, state lands, and lands in corporate ownership by railroad companies, banks, investment houses, and other forms of corporations.

As a result of this rather intermingled and checkerboard pattern of ownership, a single livestock enterprise may graze livestock in several different ownerships dispersed long distances apart. This results in higher costs of operation, lower rate of return and an inclination to misuse grazing land. Moreover, it makes management and rehabilitation of range under any single operator more difficult and expensive.

Lease Arrangements

The character of the lease arrangements influences in a major way the quality of management of range by the lessee. Many leases of corporate and private lands are on a short-term basis, and they do not provide for compensation to the lessee for range improvements made in case he does not secure renewal. If the lessee is a speculator in cattle, his interest is to utilize as much forage as possible during his term of lease. Most private range is leased on an animal-unit-month or per acre basis with no limits of range utilization mentioned and usually no season of use specified within the year of grazing. Without some management standards or incentives, the lessee has little encouragement to manage the leased lands for sustained forage yield.

National forest grazing lands are not leased out. Permits for grazing use on specific allotments are issued according to a preference system based on the rancher's location, commensurate range property for winter grazing, and dependency on public range for summer grazing. The preferences are difficult to change when range conditions show the need. Ranchers value the preferences highly. Though preferences cannot be sold, they do increase the value of ranch holdings to which they are issued.

Within this area, the Bureau of Land Management has small scattered tracts of grazing land that are leased out, according to Section 15 of the Taylor Grazing Act, to neighboring ranchers.

State-owned grazing lands, comprising nearly half the total public range area within the area and located for the most part in the four northernmost counties, are leased at nominal rates.

Grazing fees on public lands vary according to the administering agency, and according to the quality of the range. Where lands are leased out for grazing use, a flat per acre rate is usually charged. Where lands are grazed under permit, rates are set in terms of animal-unit-months of forage use. Under this system, per acre equivalent varies by range type and productivity. In determining the rates, an animal-unit-month is defined as the amount used by one cow and her calf in one month. Five sheep are considered equal to one cow and calf.

The grazing fees on the Umatilla National Forest, the largest national forest in the area, have varied in the last few years from a low of about 60 cents to a high in 1951 of 84 cents per animal-

unit-month for cattle. The corresponding rate for sheep was a high in 1951 of $1\frac{1}{4}$ cents per sheep month.

Bureau of Land Management fees in the area have varied from 20 to 25 cents in the last few years for cattle per animal-unit-month and 5 cents per sheep month. They are intended to cover only the cost of administration. On state lands the fee is usually charged on an acre basis. This has varied from 8 to 15 cents an acre. When the range land is in poor condition this is comparable with 70 cents to $1.00 per animal-unit-month.

In per acre terms, grazing fees on public lands range from about 5 cents to about 30 cents annually. Even the highest rates per acre on public range, for the very productive wet meadows, are much less than the rates charged for grazing on privately-owned land of similar quality. These fees are well below the economic value to the users, which explains why ranchers consider their grazing preferences at a premium. Because of the low rate, some livestock owners would like to overstock the range. Permittees on public range, because of the low fees paid, have an economic advantage over the users of private range.

Ranches along the Blue Mountain foothills in Walla Walla, Columbia, and Garfield counties, and large ranches in Grant and western Franklin counties have long had use of low cost Federal ranges of the Umatilla National Forest and Bureau of Land Management respectively. Their capital structure is built on the basis of relatively cheap grazing. This, in turn, has an adverse effect upon range livestock operations that do not have access to public land for grazing. Local taxes are

influenced upward by over-capitalization of private lands on those ranches having public grazing allotments.

Grazing fees and rental systems for livestock on private range have always been subject to wide variation. The increase in cattle and sheep numbers of the last few years have made the competition for pasture very strong. Rental fees have usually been assessed without regard to season and have varied in value from $1.50 to $2.00 for a cow month. This method of rental creates a double hazard to the range land and forage; first, the operator utilizes as much of the feed as possible with little thought to the protection of the soil for the coming winter season, and secondly, he has the tendency to stock the range as heavily as possible during the spring growing season when the grasses are green and at their highest protein and nutrient values.

Credit Facilities and Interest Rates

Problems of credit on the older established ranches and farms in this area are at a minimum. The net financial returns per individual ranch and farm in the area are among the highest in the Columbia Basin. Most loans for range improvements are included with regular personal borrowing for yearly operating costs, mortgage loans, or related financing. Interest rates vary from 4 percent for the National Farm Loan Associations to 6 percent for personal credit. The area is well served by offices of loaning agencies such as the National Farm Loan Associations, commercial banks, and insurance companies, in the cities of Spokane, Davenport, Colfax, Moscow, Walla Walla, Pasco and Wenatchee.

Limited Basic Information and Educational Services

Since the time that livestock first began grazing the bunchgrass ranges of the area, lack of knowledge and effective education have been as much responsible for the present condition of the range lands as any other single factor. Even at the present time the inadequacy of our knowledge and the degree to which such knowledge is being passed on to the owner, user, and administrator of range lands is a major problem.

Range Plants, Site Requirements, Runoff Relations

Knowledge regarding the condition of range lands of the area and their forage production is fragmentary. Of the 4.2 million acres of rangeland only 500,000 are covered by range surveys. Without these inventories, proper management plans cannot be made. Of equal importance are soil surveys in range areas. Soil surveys have been carried out on only 2.5 percent of the range. Soil surveys and range surveys provide the basic information for land classification and use planning.

Likewise, knowledge is inadequate regarding range plants and plant associations, their site requirements, and their abilities to withstand grazing use.

Methods for maintenance or improvement of range soils require additional knowledge. Standards of utilization for grazing use to leave plant residues for winter protection and to promote infiltration of melting snows and rainfall are only in the initial phases of investigation. To date little has been done to ascertain the effects of range vegetation on reduction of sediment and floodwaters from this area.

At present, the U. S. Forest Service is conducting a study on the relation of deer and elk to overall grazing management which should aid in correlating range use by big game and livestock in the Walla Walla and Tucannon River watersheds.

There are still some problems not solved concerning methods and forage species to use in rehabilitating badly depleted ranges. In the light soil, low rainfall belts in Franklin and Grant counties, known species such as Indian ricegrass and thickspike wheatgrass establish themselves so slowly that rather extensive and expensive structural controls are needed during the establishment period. Along the Columbia River and Snake River breaks, and on other steep ranges in Walla Walla, Columbia, Garfield, Grant, and Adams counties, there are thousands of acres of depleted range. Such drought-resistant species as crested wheatgrass and beardless wheatgrass are well adapted to these lands, but as yet economic methods of preparing an adequate seedbed are not known. It is estimated that satisfactory power equipment is not available, or methods for successful seeding have not been worked out for 80 percent of the range land on which desirable forage plants are gone or nearly gone.

Technical Assistance and Education

Even though much has been learned concerning the proper use of the range land, effective dissemination of present knowledge to the owners, user or administrator of the range lands has lagged behind the development of this knowledge. At the present time the State of Washington employs no full time range specialist. The Extension Animal Husbandman devotes what time he can to range management

problems for the state. County agents in the eleven counties, even though they may be range trained, can spend only a limited time on the ground with the livestock operator. The lack of several Assistant County Agents trained in range management and located in the counties with large acreages of range land has been a serious handicap in effecting better range education and improvement of range land conditions.

Federal agencies are doing much of the existing range educational job in connection with their related range programs, but in 1950 there were only two range specialists assigned to the area. One is the Supervisor of the Umatilla National Forest and the other is a Soil Conservation Service range specialist assigned to assist the ranchers in soil conservation districts in Lincoln and Spokane counties. At least three more are needed to provide on-the-ground technical assistance to the farmers and ranchers on the remainder of the area.

The combined Federal and state range education and technical assistance work are far from adequate in this area. Much more intensive and effective work is essential to carry present knowledge, and that being developed by research, to the owner and user of the range land. The presentation of range management education through the schools, local farmer groups, and to the individual livestock operator lacks the emphasis placed on sound agronomic practices, animal husbandry, crop varieties, improved rural living, and other related phases of agriculture. Agricultural demonstrations and tours have not emphasized range land problems which are so important in the area.

Another problem that handicaps the flow of technical assistance to ranchers is that during the period after World War II, young men have not been attracted to the profession of range management. Other professional fields have proved more lucrative and not so distant from the larger population centers.

Incentive payments for range improvements and range management under the Agricultural Stabilization and Conservation Program have been a very small percent of payments for cropland practices. Many county committeemen are not familiar with the standards for better range management in their own areas of responsibility.

FOREST LAND PROBLEMS

Though forest land is relatively limited within this area, it is important in the local economy and has many problems deserving attention. Some of these problems are concerned with forestry and forest practices, some are concerned with conflicts between other uses and growing a timber crop. Nearly all of these problems are found in common with those of other forest areas.

Problems of forest management include certain considerations with regard to harvesting present crops of mature timber, to establishing regeneration of a new crop, to improving quality in young stands, to encouraging the more desirable timber species to hold the site. Spreading the harvest of mature timber over a sufficient period of time to permit cutover lands to come back into production and to permit present young stands to reach their best growth and merchantability, reducing losses from fire, insects and disease, and salvaging damaged timber are problems common to forest use. Methods

of logging that will not disturb the productivity for timber need to be developed and encouraged. Regeneration to start a new timber crop on cutover lands and improvement in the quality and rates of growth in young stands of the more desirable species, ponderosa pine and western white pine, are important where certain practices favor the less desirable firs, hemlock, larch and spruce.

Management problems for forest land also include the protection of soil characteristics which serve to regulate water yields, the stabilization of soil on the slopes which might otherwise erode to become damaging sediments in the streams, and the correlation of other uses with growing and harvesting the timber crop. They include further the regulation of all uses to promote the greatest total use. Control of big game and livestock numbers to get full use, but not over-use, of the forage would save many young trees from damage and help to maintain the soil in good condition. Full enjoyment of scenic and other recreation values, while avoiding impairment of water quality, is possible.

Sustained Production

Growth of timber slightly exceeds the drain from all causes. However, much of the growth is made by the less desirable timber species. As the more valuable pine species have been cut, the less valuable firs have come to dominate the stands. Several problems are involved here; perhaps greatest is that of getting better utilization of the less valuable species so that they will be taken in amounts proportional to their volume.

Half of the forest area and nearly half of the commercial timber volume are in private ownership. Rates of cutting, however, are three times as great on private lands as on the public lands because public timber is less accessible. The pressure on accessible timber disturbs the balance of harvest and leads to poor cutting practices on the private forests.

Timber in the older trees is perishable, subject to attack by insects and fungi, growing slowly and not making full use of site productivity. It needs to be harvested to make room for vigorously growing younger trees, to prevent loss by whatever cause, and to relieve cutting demands on more accessible rapidly growing young stands.

Forest Management

Because of the great demand for lumber, harvest of desirable species exceeds growth. More intensive utilization is needed. Again because of the demand for timber, some forest owners follow destructive cutting practices. Too much of the healty growing stock is being taken before it has reached its greatest productivity. Ponderosa pine, the cream of the crop, is being skimmed off; and forests of pine mixture are being converted to forests of low-value species. Quality of second-growth stands is threatened by premature logging. Stand regeneration is a problem on other areas not fully stocked.

Problems associated with logging methods are numerous. Erosion removes the soil from unstabilized road fills and cuts, from uncontrolled drainage ditches and skidtrails. Soil compaction and churning in heavily-used skidtrails and landings may lower site productivity and make regeneration difficult over as much as 20 percent of

the logged area. Large clearcut openings change the microclimate; snow accumulation and melt rates are affected, sometimes adversely. Slash burning often is done in such a way that the mineral soil is left exposed to the elements; erosion carries ash and silt to the streams.

Some of the timber grows on municipal watersheds. In harvesting this timber, particular care must be taken to protect water quality. This involves road location, road construction methods, logging methods, and sanitation. All phases of the harvest must be planned with regard to soil, topography, and climate, to prevent erosion and sedimentation or turbidity in the streams.

Serious problems in the use of heavy machinery in the woods are the wounding of tree trunks (leaving scars for easy invasion of insects and fungi), the damage to tree roots, and interference with soil drainage by soil compaction.

There is practically no market for products of thinning and sanitation cuttings. The lack of a market restricts more intensive utilization.

Ownership Problems

Ownership problems are important. Small owners are least able to practice good management. They cannot plan for a sustained yield program, protection is costly, and the stands are usually high-graded. Small owners need technical assistance in bringing their holdings to full productivity.

Privately owned forest lands present several problems. Size of ownership as it affects management has been mentioned. Small timber

holdings are often subject to liquidation cutting; the cutover land becomes tax delinquent, and the productive capacity of the site is lost as the growing stock is removed. More study of the tax problem is needed to devise taxes in accord with production value of the land in line with other properties and industries, to develop uniform methods of assessment, and to make the shift in taxing method without penalizing owners who have been paying taxes for years under earlier methods.

Studies are needed on the financial aspects of forest ownership. Assistance from banks and public loan agencies to forest operations should be based on better knowledge of timber values. Forest management is a business. That risks involved are not out of line with those of other businesses is shown by the large privately owned forest area now being managed for permanent sustained timber production. Appreciation of the status of the business and the risks will lead to solution of insurance and credit problems.

Restocking

On about a third of the commercial forest area, timber stocking is below that necessary for full production. These areas present a problem of restocking to get the new crop started immediately and to insure return of desirable timber species. Other obstacles to regeneration--fire hazards, brush competition, and rodent depredations--must be hurdled before trees can be readily established. Natural regeneration is spasmodic; good seed years and good establishment seasons coincide only once in six to ten years. Immediate artificial restocking will save years of time in growing the next crop and take full advantage of the productivity of the site.

Some of the obstacles to reforestation have been cited. Fire, brush, and rodents can be handled in various ways. However, research is needed to find methods of restocking difficult sites successfully and cheaply. Surveys are needed to determine areas in need of restocking and to find out differences between various sites. Although new cutovers and burns on the national forests are generally restocked fairly soon, there is a large forest area needing attention because of reduced stocking from past abuse.

Forest Protection

Although forest protection, against fire, disease, insects, etc., is a significant problem in any forest management, it is particularly important to the small forest owner. Good management practices can minimize the damage from these destructive agents, but the problem of control extends beyond the limits of any one ownership or political boundary. Forest protection therefore is a combined Federal, state, and local ownership problem. Though fire, disease, and insect epidemics receive considerable attention and adequate methods of combatting them have been developed, there are also other factors needing attention. Research is needed on control of porcupines and other rodents, mistletoe, and big game herds.

WATER PROBLEMS

Problems of water management stem from the variation in annual amounts of precipitation and in the seasonal distribution. Runoff rates fluctuate even more than precipitation because of the proportion that occurs as snow. Minor floods cause considerable loss every year in some part of the area through inundation and sediment deposition.

Most of the western channels and many in the foothills are dry during the summer season when only the spring fed streams continue to flow. Irrigation supply disappears and stock either drink from wells or follow the water to higher elevation range.

Erratic flows carry more sediment than steady flows, making the flash flow streams unsuitable for domestic use or fish propogation and inferior for livestock unless settling ponds are used. Irrigation quality is satisfactory at all times in the area.

Water Excesses

Uncontrolled flood flows in the area cause an annual loss of 3,000,000 dollars in crops, land, improvements, roads, bridges, irrigation systems and urban centers. This also includes indirect losses which accompany each flood occurrence, consisting of such secondary effects as loss of time, isolation of farm and urban residences, decline in business activity, and loss in employment opportunity. The estimated annual monetary losses from flood water and sediment in the Big Bend-Palouse-Lower Snake area are summarized in Table III-1.

Floods occur in two general ways. Seasonal flood flows result from rain and snow melt in the winter and early spring. Also considerable damage results from intensive convection-type storms in localized areas, some of which are of "cloudburst" proportions. Overland flows will take place any time the water, from whatever source, reaches the surface more rapidly than the infiltration capacity of the soil will absorb it. The critical events causing major floods are unseasonable warm weather with melting of snow, accompanied by rainfall or warm wind, or both over a considerable area.

Minor floods occur at 2 to 5 year intervals, and major floods about once in 25 years. Major floods seldom occur over the entire area the same year. There were disastrous floods on the Walla Walla River watershed in 1882, 1906, and 1931, with a frequency of about once in 25 years. On the Palouse River, major floods were recorded in 1910, 1933, and 1948 with three floods of major proportions over a two-month period in the latter year.

The 1910 flood on the Palouse River was of the greatest magnitude observed on that river. The peak flow recorded at Hooper, Washington was 27,800 second feet, 13.0 cfs per square mile. Floods of this magnitude can be expected to occur once in about 50 years. The 1948 Palouse River flood approached the 1910 flood in magnitude with a peak of 24,700 second feet measured at Hooper.

Local floods in the foothill agricultural areas occur as frequently as once or twice annually from general storms of low intensity. These floods add but little to the magnitude of major stream flows. Losses have been estimated for a few of these occurrences, such as the June 17, 1950 storm near St. John, Washington, which caused an estimated loss of $41,852 and the storm of June 16, 1950 in Linville Gulch near Pomeroy, Washington, causing an estimated damage of $68,693. In this latter occurrence, three lives were lost. In the June 7, 1947 storm in Woodward Canyon west of Walla Walla, Washington, estimated loss amounted to $29,000.

The amount of damage associated with each flood is determined by a combination of physical factors in conjunction with the agricultural, economic and cultural development of the area. The

physical factors may be briefly listed as precipitation, temperature, soils, topography, vegetative cover, and geology. The chief variants are precipitation and topography throughout the area. The area has been divided into two general zones of flood magnitude and typical flood losses for each zone described.

1. The 10 - 20 inch precipitation zone.
2. The desert-like section consisting of the 6 - 10 inch precipitation zone of the southwestern portion of the area.

Damaging runoff is more frequent and severe in the zone where the annual precipitation exceeds 10 inches. This zone covers the eastern half of the area, that portion east of a line joining Davenport, Ritzville and Touchet. It also includes Douglas County.

Sediment produced by erosion of the cultivated hill lands is carried to the more gentle slopes and bottom land where a portion of it is deposited, frequently smothering out the wheat crop. These areas of crop loss by sedimentation are numerous but, generally too small and scattered to reseed, resulting in complete loss of the crop. This one item of crop loss due to sedimentation amounts to an annual loss of approximately $479,000 or 75 percent of the total agricultural flood damage in this zone.

Sediment from the cropland carried to the bottom lands also causes extensive damage to farm fences. Fences have been almost buried by deposition in a period of 15 to 25 years. The roadside ditches and borrow pits of the county roads, state highways and the railroads are also filled by sediment. Road culverts are plugged and bridge capacities are impaired. The result is overflow of

roadbeds causing increased deposition on the highways and frequent washouts necessitating high annual expenditures for sediment removal and road repair.

Flood waters in the main drainways deposit sediment in sections of the stream channels, choked with willows and debris. The restriction of channel capacities in turn gives rise to more frequent and extensive overflow of adjoining bottom lands. This situation increases streambank erosion, land scouring, and the formation of new channels across the flood plain. In other locations the bottom lands are being gradually built up by deposition resulting in increased damage to crops, fences, improvements and road facilities. For example, in the lower reach of Union Flat Creek in Whitman County the build up of the flood plain over the past 50 years has resulted in the frequent flooding of farmsteads and land areas that were originally above high water. Also the elevation of the land surface has become higher than the county roadbed forcing the regrading or relocation of approximately 8 miles of roads. The more frequent flooding and the inadequate channels have also resulted in a wet soil condition. Out of a total of 2,090 acres of land subject to flooding approximately 1,035 acres has been adversely affected. This condition has resulted in an estimated annual loss of $27,800 from reduced yields and prevention of crop production.

On a few streams flood flows have done extensive damage by channel entrenchment caused by the comparatively rapid upstream movement of a series of overfalls. The entrenchment produces channels from 10 to 50 feet deep and from 25 to 250 feet in width. Besides

the loss of land by erosion there is a material reduction in yield by the desiccation of the valley lands. The enlarged channels also create a problem of maintaining farm bridges which are frequently washed out and have to be rebuilt or continuously repaired to accommodate the wider channels. The rapid entrenchment of stream channels is typified by lower Dry Creek in Walla Walla County where the loss due primarily to stream channel entrenchment has been estimated to be $96,500 annually. A similar, but less acute, problem exists on Willow and Mud Creeks in Whitman County on Deadman Gulch and Pataha Creek in Garfield County, and Douglas Creek in Douglas County.

The urban centers, throughout the annual cropping zone, generally located on the floodplain lands, are subject to considerable floodwater and sediment damage during periods of major peak flows. Losses result from the overflow of streets and the inundation of business, industrial, and residential sites.

Extensive damage has occurred to the towns of Colfax and Pullman, which are subject to an estimated average annual loss of $107,350 and $69,050 respectively.

Other urban centers subject to similar damage but in lesser degree are Rosalia, Garfield, Palouse, Oaksdale, Thornton, Farmington, St. John, and Endicott in Whitman County; Moscow, Idaho; Pomeroy in Garfield County, Dayton in Columbia County and Waitsburg and Prescott in Walla Walla County.

Damage to irrigation and drainage systems from floodwater and sediment is largely confined to the vicinity of Walla Walla and to small isolated irrigated fields along the major streams. The

principal damage consists of the cost of removing sediment from canals and ditches, and repair of diversion structures.

The uncontrolled runoff from Douglas Creek has caused extensive damage to the irrigated lands in Moses Coulee. The swift flowing waters of Douglas Creek spread out over the relatively flat land of the Coulee and deposit rock, sand and gravel to depths of 1 to 3 feet. The 1948 flood caused damage to some 1,000 acres in Moses Coulee. The Corps of Engineers has estimated the damage from the 1948 flood to be $1,075,000, of which $1,000,000 was to the Great Northern Railway. They also estimated the average annual damage in Moses Coulee and along Douglas Creek to be $20,400.

The low lying plateau area of the southwest portion of the Big Bend-Palouse-Lower Snake area consisting of Grant County, part of Douglas County, Franklin County and the western fringe of Walla Walla County experiences very little floodwater and sediment damage. The annual rainfall in this area is from 6 to 10 inches. The storms are generally of low intensity and do not produce damaging flood flows. The area is largely devoted to the marginal production of dryland wheat and to utilization as rangeland. It is within this area that the future development of the Columbia Basin project will bring under irrigation over 1,000,000 acres of land. However, because of the low annual precipitation and the absence of high intensity storms over the area the potential flood and sediment damage, after development, will be relatively unimportant.

Along the Columbia River there are numerous small watersheds with short steep drainways. Frequently these drainways cross the

highly developed orchards on the bench land area along the Columbia River. Floods on these steep watersheds cause spectacular damages to land and property. Typical of these conditions is the 1,200 acre watershed that produces damaging flows across the orchard land just north of Orondo. On a few acres of orchard land the loss produced by the June, 1948 storm was estimated to be $51,300. The main item of damage was land destruction by sediment and debris and the cost of cleanup and removal.

Floodwater and sediment damage to transportation systems including state highways, county roads, and railroads is generally moderate throughout this area with the exception of railroad and highway damage along Douglas Creek.

Water Yields

The Big Bend-Palouse-Lower Snake area is one of the major water deficit areas in the Columbia Basin. Except for the Potlatch-Blue Mountain block and most of Douglas County water yields are 1 inch or less annually. Moses Coulee, Crab Creek and the northern tributaries of the Palouse River (Cow and Rock Creeks) drain an area which receives an average of only 10 to 15 inches precipitation per year. The direct drainage of the Palouse, Snake and Walla Walla Rivers is also in this low precipitation belt or zone. Precipitation in the Potlatch Mountains averages some 40 inches per year at the headwaters of the Palouse River while in the Blue Mountains at the head of the Walla Walla River, annual precipitation reaches a maximum average of over 50 inches. It is apparent, therefore, that only a very small portion of the area has an appreciable water surplus while most of it

Table III-1.--Summary of evaluated average annual damages
(1949 prices)

Item	Washington	Idaho	Oregon	Total
	dollars	dollars	dollars	dollars
Direct Agricultural				
Floodwater				
Crops	249,900	14,600	20,200	
Property	79,900	2,300	5,500	
Land	98,500	5,300	11,500	
Miscellaneous	12,200	1,200		
Sediment				
Crops and improvements	419,400	76,000	900	
Land	67,100	500		
Miscellaneous	9,700			
Floodwater and Sediment				
Farm irrigation and drainage	4,100			
Farm roads and bridges	40,500		8,200	
Miscellaneous	1,600			
Total	982,900	99,900	46,300	1,129,100
Indirect Agricultural	272,700	30,000	9,200	311,900
Damage along main streams 1/				65,200
Total agricultural damage				1,506,200
Other direct evaluated damage				
Federal roads	8,300	1,200	1,400	
State highways	92,000	2,100	900	
County roads	918,300	26,500	10,000	
Railroads	235,300	2,300	4,000	
Irrigation and drainage systems	7,500		2,900	
Urban and industrial 2/				
Total	1,261,400	32,100	19,200	1,312,700
Indirect damages	50,200	1,300	900	52,400
Damage along main streams 1/				136,600
Total other evaluated damages				1,501,700
Total Damages				3,007,900

1/ Damages reported by the Corps of Engineers, which will remain after the authorized projects are constructed, and damages for which no projects are authorized. Not available by states.

2/ "Urban and industrial" damages evaluated by the Corps of Engineers not segregated, but are included in total "damage along main streams."

has a severe water deficit during most of the growing season.

Stream Flow

Stream flow, from a water yield standpoint, may be neglected in most of Grant County because it is so low as to be insignificant except to a few individuals who use spring flood flows to irrigate small valley fields. Water yields by stream flow, as illustrated by Crab at Irby, amount to an average of an inch or less per year in this dry area or about 50 acre feet per square mile.

Streams issuing from the mountains yield somewhat more water. Those draining the Blue Mountains have higher water yields. The South Fork of the Walla Walla River, for instance, which heads in the central Blues, has an average annual water yield of about 36 inches over its watershed. The Tucannon, heading in the north end of the Blue Mountain range, yields some 16 inches from its drainage area. The North Palouse River near Potlatch, Idaho, draining part of the Potlatch Mountains, has a water yield of about 12 inches per year. Missouri Flat Creek, heading in the foothills of the Potlatch Mountains, has a yield of only 3 inches per year. These average annual water yields of representative streams issuing from the mountain areas indicate the availability of several hundred thousand acre feet per year.

The pattern of stream flow, however, is such that relatively little of this water is available at the time of greatest need, the summer months. Slightly over one-fourth of the seasonal Walla Walla River flow occurs in the four-month period June through September. On the Tucannon, less than one-fourth of the seasonal flow occurs in

the same period while on the North Palouse River less than one inch of water yield out of a seasonal average of 12 inches occurs in the growing season.

The stream flow water problem in the area is two-fold. Over most of the area there is no significant water yield. In order to supply this large area adequately, water must be imported. The only adequate irrigation sources for the west half are the Columbia, Pend Oreille, Spokane and Snake Rivers. The problem in the east half entails storage of high late winter and early spring stream flow for summer use.

Ground Water

Ground water problems of this basin area are principally those of great depth to water, making it expensive to develop, and lack of knowledge as to the location, extent and safe yields of ground-water aquifers. Its quality is generally good being slightly hard in the western arid zone. Ground water lies at such great depths over much of the area that it is uneconomic to develop it for irrigation. In much of the area ground water is at such depths that it cannot be economically developed by the individual for domestic and livestock use. Ground water is available in quantities necessary for domestic and livestock use over practically all of the area. It is found at depths ranging from 30 to 350 feet in the Quincy Basin and Pasco slope. On the Wahluke slope water stands at 300 to 550 feet depth. Cost of well development is high, ranging from $5 to $10 per foot.

Ground water is available in the areas adjacent to the Blue and Potlatch Mountains. Artesian aquifers producing municipal supplies

exist in the Moscow-Pullman area in Latah and Whitman counties, and in Garfield County in the vicinity of Pomeroy. Both artesian and free ground-water aquifers capable of producing irrigation quantities are well developed in the Walla Walla River Valley, in the Milton-Freewater and Walla Walla area. Some ground water exists in the alluvial valleys of the Touchet River and in the vicinity of Moses Lake within 100 feet or less of the surface.

Moscow and Pullman use ground water for municipal purposes. Water pressures in this area have been declining steadily for many years up to the last two or three years when they rose slightly. It is doubtful, therefore, if any extensive new developments of ground water are possible in this area. In Garfield County, the depth to the aquifer underlying the area is prohibitive except in the canyons.

Water Quality

Problems of water quality in the Big Bend-Palouse-Lower Snake area are important to some 168,000 persons residing within the area, fifty-five percent of whom the census classes as rural. They use the water resources for domestic, agricultural and industrial purposes, and its importance to them is in about that order.

The major sources of water are Roosevelt Lake, the Palouse, Snake and Walla Walla Rivers and their minor perennial tributaries in the southeastern fringe. Over the extensive central part of the plateau there are no perennial streams as sources of water except for use of livestock. Ground water is the dependable high quality source of domestic, livestock and limited irrigation water supplies.

The people who use the waters are scattered over 57 towns or municipalities and about 9,000 farms. Irrigation use on 1,700 farms spreads water on 60,000 acres of land. Of the 57 communities with municipal water supplies, 43 use only well water, eight use springs and wells and three each use water from the Columbia River and from the Walla Walla River system. Over 45 percent of the people, both urban and rural, are dependent on ground water for their domestic supplies. All the housewives know it is "hard" and soap requirements are heavy.

The quality of the ground water for domestic purposes is partly reflected in statistics on the municipal supplies. Thirty-nine towns use the well water without treatment, four chlorinate well water, seven chlorinate a combination of well and spring water.

Most of the municipal water is pumped from relatively shallow gravels in the glaciated channels. Much of the farm water used on the plateau is pumped from greater depths between basalt layers or from porous basalt. For domestic purposes the chief water quality problem of ground water supplies is its "hardness". Of the six municipalities that use water from the Columbia and Walla Walla River systems, four filter the river water. Turbidity exceeds 10 parts per million for an extended season especially during flood and spring runoff season when the waters are more murky than usual.

Of the 60,000 acres now irrigated, on about 40,000 acres water from the Columbia and Walla Walla River systems is used, and on the remaining 20,000 acres water from the internal intermittent streams and from the ground water supplies is used. The river waters carry

silt during the flood season, generally during the months of June on the Columbia and April on the perennial tributaries. Time of the spring runoff varies on the intermittent streams but their silt load is always heavy.

Over this entire area alkali and salinity affect crop production on some 20,000 acres of land. The problem has been sufficiently severe to cause abandonment for crop production on only a small percent of that acreage. This is not so much a reflection of water quality entering the affected area as a warning of possible reuse of drainage water below.

Quality of water is adversely affected in some areas by the discharge of sewage into the streams. In this area only five towns discharge sewage into the Columbia River, which borders the north and west sides of the area. Five other towns have provision for use of the sewage affluent as irrigation water on otherwise dry land. Ten towns discharge sewage into dry gulches. Within the area little sewage goes into water reused by others.

Watershed Management

Dirty streams have become accepted as an inescapable consequence of settlement and use of the land. Whether the crop was timothy, timber or tobacco, turbidity has inevitably followed the harvest. Water becomes progressively unfit for fish, fowl, livestock and man as the processes of erosion continue uncontrolled.

Streamflow becomes more erratic with higher flood peaks and lower minimums as the watersheds become less and less capable of absorbing precipitation as it falls. Watershed management has largely

lost the battles with exploitation in the past through fires, cultivation and overgrazing.

Watershed protection by control of fire has progressed to the point where only a few people ignore the danger while in the woods or on dry ranges. Cultivation and grazing measures are not so advanced. Even the deer and elk are allowed to increase to the point where denudation of watersheds and game starvation go hand in hand with erosion and murky rivers. That the phenomenon appears by cycles indicates a lack of management at some point.

Overstocking by livestock has much the same effect of removing desirable vegetative cover and trampling to a waterproof layer the bare top soil. Cultivation with heavy high speed machines breaks soil structure to the point of fineness that wind easily lifts it into the air. On sloping ground the machine so energizes the soil that it walks down the slope during cultivation without assistance from wind or water.

Grazing and cultivation effects lack the short cyclical character of big game consequences. They may now have reached the low point from which improvement is possible, but the cost of water purification, recreation and production continue to mount.

Fisheries

Watershed protection as a means of preserving fish population has failed in cultivated areas. Seasonal flow fluctuation is unavoidable because of the concentration of precipitation into the winter and spring months, and no amount of watershed practices would alter that situation. Logging and fire in headwaters have, however,

caused drastic changes in stream regimen. Siltation of spawning areas and overheating of water in summer result from too thoroughly stripping a forest cover, either by fire or by machinery.

Tributaries of the Palouse River are practically devoid of game fish except for the lakes on Cow and Rock Creeks. Silt, pollution and irrigation diversion have almost eliminated the salmon and steelhead runs of the Walla Walla River. Flood control channels seldom provide best conditions for fish spawning or habitation. The Tucannon River alone maintains some resemblance to its original condition because its watershed is not susceptible to cultivation. It supports small runs of steelhead and silver salmon because it provides good spawning areas unaffected by the silt and organic wastes so common to other streams of the area.

PROBLEMS OF UNDIFFERENTIATED AREAS

Improper Land Use

Improper land use means that the land has been used destructively, unproductively or unprofitably. The present pattern of land use in this area has evolved on the basis of trial and error from the time of settlement to meet unknown climate and soil conditions. Drastic changes in the major kinds of land use are unlikely but considerable improvement is possible. Comparison of research findings with actual conditions on farms indicates that much better information is available than is being used by many farm operators. Exploitative farming and get-there-first grazing have exhausted the virgin soil resources, and the continuance of original use is or will be destructive, unproductive and unprofitable.

Experience has shown that some lands and soils are better adapted for growing cultivated crops than are others and that certain soils will erode badly if original cover is removed or if cultivated. Shallow and thin soils, sandy soils, and soils with insufficient stability of structure have been misused, and this in turn has lead to crop failure, soil deterioration or destruction and field and farm abandonment.

Similar changes are still in progress. During the 70-odd years since this area was first homesteaded many fields, steads and farms have been abandoned and again reclaimed. Financial institutions have over-estimated the productivity of lands under intensive cultivation. Eroded fields, abandonment and financial loss have resulted. Classification of the lands to determine the use to which they are best adapted is needed on many acres in this area. Estimates place 200,000 acres as needing to be converted from cropland to grassland and that some 8,000 acres could best be used for woodland. Similar appraisal of the soils estimates 4,000 acres now in grass could be used for crops.

Adverse Effects of Large Dams

Within this area, additional large dams are in prospect for the lower Snake River and for the irrigation project to the north. On the western border, more dams may be built in the Columbia River. Construction of these dams will require some relocation of present highway and railroad routes. Some agricultural land and wildlife range will be flooded out. However, the contemplated dams will not create serious problems for the range and forest lands.

Conversion of Agricultural Land to Other Uses

Urban areas are constantly extending their influence on land use to adjacent areas. Improved transportation facilities and shorter work weeks have encouraged many people to move out in the country. This movement into the country has frequently meant subdivision of favorably located farm units into many small tracts. Some of these tracts are part-time farms while others are rural residences. In general, the total agricultural production for those subdivided units is considerably less than the original unit. Many times nearby farms will be taken out of production prematurely in anticipation of its subdivision into smaller units.

This urbanization of rural areas affects the economy in many ways. Frequently, the nearby farmers find that the assessed valuation of their properties goes up with this development. The farmer must intensify land use to meet the additional tax load. If the valuation and taxes go up high enough, then the farmer will be forced to convert his land from farm use to urban use. In general, this urbanization greatly increases the demand for public services--school, policing, fire protection. This means, at times, a higher per capita cost for providing the desired government services until population density increases sufficiently to make the service operate at optimum efficiency.

Many of our roads are built through the best farm lands. Normally, settlement will take place along and off these established roads. This means that many times the best farm lands are being used for urban development. This problem is acute in many of our

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small irrigated valleys as people move out from the city into the irrigated areas. The already limited agricultural resources in many of these valleys are further reduced by conversion of these lands into urban use.

Past history of expanding military and national defense sites has indicated that many times our basic agricultural resource has been reduced by these activities. For example, the Atomic Energy Commission has taken over a large acreage of land which was included in the Columbia Basin Irrigation Project. The withdrawal of the land not only removes this land from possible agricultural use, but it also affects some adjacent lands which could more readily be developed as a complete development unit. Military sites frequently take highly productive lands. The military air base near Walla Walla is an example of some of the better land being removed from agricultural use.

If we had unlimited agricultural resources, the conversion of these lands from agricultural to non-agricultural use probably would not need to be considered as a major problem. The fact remains, however, that our agricultural resources are limited. It would appear that we should be concerned with any additional conversion of this basic resource which for all practical purposes is not replaceable once taken out of agriculture.

New Drainage Projects

While no drainage projects are blueprinted within the area there is one block of approximately 10,000 acres along the middle reaches of the Walla Walla River where drainage is necessary before agricultural

development can proceed. Extensive areas of alkali and salt infected ground complicate the problem and increase the cost of reclamation.

Irrigation of a million acres of presently semi-arid land area in the Columbia Basin Irrigation Project will create drainage problems which makes the entire development a drainage as well as an irrigation project.

The net effect on both water fowl and upland bird population will be beneficial through the increase of food supplies in both areas and the creation of numerous small lakes and ponds in the proposed irrigation development.

Under present conditions of water supply and cost of alkali removal the Walla Walla area reclamation is of doubtful economic value. The Columbia Basin Irrigation Project drainage will become an economic necessity to scattered areas throughout the project. Development of storage facilities for irrigation water on the Walla Walla watershed will permit expansion of irrigated areas and provide water for leaching the salts from areas not now cultivated. When that development is accomplished, drainage of the area will probably become a feasible undertaking.

There is need of a number of small projects along flood plains of the Palouse River tributaries in south central Whitman County and in the bottomlands of Crab and Wilson Creeks. These are for removal of late spring precipitation and flood waters and are not generally complicated by the presence of salts or alkali.

Mining and Minerals

Exploitation of mineral resources is highly incompatible with the preservation of surface resources not only because of the nature of the operations but also in the conflict of interest and points of view of individuals responsible for development of each. Patent of title to a mining claim on public land includes surface rights without requiring clearance through, or notification of, the land administering agency. The least damaging result is confusion in carrying out a watershed program.

Evaluation of the alternative developments of mineral or surface resources would indicate the direction in which development should be encouraged. If the proposed placer mining of a potential agricultural area shows a negative net public return then placering should be prevented. Surface values have increased greatly since passage of the mining laws, making stream pollution, alternative production and watershed deterioration more important considerations than formerly.

In this area mining activity has been largely confined to the semi-circle of forested watershed containing the headwaters of the Palouse River. Scattered placer prospects were developed during the 1930's and later abandoned. Gold mining is now in operation in the watershed of Pine Creek east of Wenatchee and in the Gold Hill area near Potlatch. Possible sites for copper development exist east of Harvard in the Palouse headwaters.

Outside of the St. Joe National Forest the problems relating to mining and mineral production are of minor importance.

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CHAPTER IV

PROGRAM

CONTENTS

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(continued)

TABLES

GENERAL

Program Scope and Objective

The basis for this program is an inventory of the land and water work that needs to be done in the area irrespective of land ownership. It is intended as a means of integrating the various program and activities of the Department as well as those of other land administering agencies which directly affect the conservation, development and use of land and water resources.

Authorization and implementation of this program will provide for the acceleration and adaptation to this area of activities and services now administered in accordance with national patterns. These various activities and services are scheduled consistent with the needs of the area. This is accomplished by consolidating the programs of all land administering agencies into a single plan of proper land and water use, designed to increase production while maintaining the soil and watershed resources.

The application of the practices and measures described in the following pages would conserve soil and provide for more efficient utilization of water. They would preserve the productive capacity of the forest and range while providing watershed protection and improved recreation facilities both of which provide encouragement for the development of appropriate wildlife population.

In Chapter V the practices and measures included in this program which have values in the prevention of flood damage are considered separately. This chapter, which includes an evaluation

of the economic feasibility of these measures and practices serves also as an appendix to the flood prevention survey report for this area.

These practices and measures are of two types; the structural measures designed primarily for the prevention of floods; and the land treatment practices and measures which have values in preventing floods by causing increased infiltration and reducing sediment.

Program Phases

All of the measures necessary to accomplish the objectives of erosion control, increased organic matter content and infiltration rates constitute the conservation phase of the agricultural program. To maintain permanent production demands that the conditions of this program be met sooner or later, depending on the rate of decline of particular areas.

Standards of accomplishment take the form of maximum and minimum limits whose attainment is the goal of the land program. Soil erosion loss for example should be kept below 5 tons per acre per year; a standard that applies to all types of land use. Organic matter content maintained at 3 percent of the soil provides another objective applicable to all types of land cover. Another general objective is the attainment and maintenance of an infiltration rate of about 0.5 inches per hour.

Other measures designed to maintain or increase production are applied as economic pressures indicate the need. They may be called secondary measures from the point of view of permanent agriculture because they may be discontinued at the convenience of

an individual operator without permanent damage to the land resource. This part of the program includes such measures as drainage, fertilizing for increased production, forest pruning and sagebrush eradication.

Conservation, Development and Use
(Cropland Measures)

The conservation, development and proper use of cropland will be accomplished by more extensive application of practices and measures to minimize erosion, in all its forms, conserve moisture, improve the soil, increase production, aid in flood prevention, improve farm drainage, improve irrigation, and enhance the values of rural living. Erosion will be reduced by protection of the land from the destructive effects of water and wind. By changing to a better adapted land use, by preventing the accumulation of harmful quantities of water, by increasing the waterholding capacity of the soil, and by slowing the movement of water along the land surface, the soil and water resources will be conserved. Adding such management practices as are required to maintain or increase fertility assures the sustained production necessary for economic farming.

The reclamation of wet and alkali areas provides another source of productive land amounting to approximately 80,000 acres. While this is only 1.5% of the total cropland in the area, this practice will become even more essential as additional lands are put under irrigation.

The plan to increase the acreage of irrigated cropland from 59,800 acres to over 1,088,000 acres with the development of the

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Columbia Basin Project shows the necessity for those practices to conserve water and improve farm irrigation.

Cost of the program will be economically justified by the prevention of soil deterioration, reduction in flood damages, and sustained and increased crop production. The final measure of the value of conservation practices is found in the ability of the land to feed its people. To maintain or improve this ability of the land is the ultimate aim of the cropland program, and its attainment depends upon using the land within its capabilities and treating it according to its needs.

(Rangeland Measures)

Rangeland occupies 4,230,000 acres or 42 percent of the area. About 630,000 acres are in public ownership; 355,000 acres being owned by the state. The U. S. Department of Interior through its various bureaus owns 168,000 acres. Perennial grasses and forbs make up the cover on 2,500,000 acres; while sagebrush is the dominant plant on another 1,500,000 acres. The publicly owned range, however, is more than half in sagebrush cover. Condition of the public range is about evenly divided among good, fair, and poor for all cover types. Private rangeland, generally, is in comparatively better condition.

As noted elsewhere, rangeland problems have developed through overuse of the forage, through invasion by undesirable forage species or by noxious weeds, and through lack of sufficient management facilities. Measures needed to improve the range include elimination of undesirable plants, reseeding to better forage

species, fencing, development of stock water facilities, game management to control overlapping use, and intensive livestock management to control livestock numbers according to amount and condition of forage available. On certain areas where overuse has been extreme, soil stabilization and erosion control measures are also needed. Grazing use of such areas must be restricted until such time as soil and cover have returned to good condition.

(Forest Land Measures)

Forest land occupies some 582,000 acres, or slightly less than six percent of the area. About 275,000 acres are in private ownership, an equal amount in Federal, and the remainder in state ownership. Saw timber and pole stands cover 60 percent of the forest lands, seedlings and saplings, 20 percent, and the remainder is poorly stocked or denuded or non-commercial. Total timber volume is one and three quarter billion board feet.

Problems cited earlier arise from indiscriminate past timber cutting without regard to good forestry practices, from overuse of various forest areas for grazing by both big game and livestock, from timber losses by fire and insects and disease. Measures in the forest land program aimed at combatting these problems include such things as increased protection against fire, tree planting, thinning, road building, drainage control on roads and skidtrails to prevent erosion, reduction of rodent populations in areas of heavy concentration, eradication of invading brush, etc.

Of even greater significance, perhaps, are the changes in management planned. With regard to privately owned lands, these

will have to be brought about by education of the landowner, by further technical assistance, and by cooperation in various projects. Generally, the management improvements will involve better utilization of timber, particularly the less valuable species, additional care in planning and supervising cutting operations to avoid damage to the site and to trees left uncut, more attention to drainage control and soil stabilization in road construction, extension of insect and disease control surveys and operations, provision for rapid salvage of timber damaged by whatever cause, arrangement for closer control of big game numbers, etc.

(Measures Not Related to Land Cover)

The conservation, development and land use measures which are not associated with any one kind of land cover have been divided into four groups.

Practices for erosion control on critical areas. These are practices that generally require the installation of special control structures. They include measures needed for roadside erosion control; stabilization of slips, slides, gullies, sand dunes, and "blow-outs"; and to stabilize miscellaneous waterway channels or outlets. The roadside erosion control is needed on sections of road rights-of-way throughout the area. Because the topography is rolling, road construction has necessitated making cuts with rather steep banks that are left bare and unprotected. The borrow pits, in many cases, are on grades that erode badly.

The practices to stabilize slips, slides and gullies are needed in the steeper eastern part of the area in Whitman, Garfield and

Columbia counties, while the needs for stabilizing sand dunes and "blowouts" are in the western part in Grant, Adams and Franklin counties. Here small desert-like areas, where the soils are light and sandy, are subject to blowing and drifting during the windy season.

There are waterway channels and outlets that require stabilizing in every county in the area, with the major need being in Whitman, Lincoln, Columbia, Adams, and Spokane counties. These are predominantly on cropland, not necessarily critical erosion areas.

Many of these critical eroding areas are not farmed but supply much of the silt that muddies the water and results in sediment deposits on roadways, drainage ways, irrigation systems and agricultural lands down stream.

Water conservation practices. This small group of practices is for conserving the available water supply and maintaining and improving its quality. It includes practices to augment the ground water supplies, keep the streams and lakes free from pollution by industrial refuse and waste materials, and make use, to their full capacity, of the multiple purpose water storage potential of the area. With the increased development in this section there will be an increasing demand for water for industrial development as well as for irrigation and domestic use.

Developing new irrigation facilities. These are for new lands or lands not previously receiving water. This is an important practice in the area. While most of the land to be irrigated

in this area will be with water from the Columbia River, there is some land in the area for which wells and reservoirs will be developed. These new developments for irrigation will require pumps, measuring devices and control structures for delivering the water to the land.

Wildlife management measures. In this area of over 10,000,000 acres there is a need for wide application of wildlife management. Here the interrelation of wildlife production with the management of other land resources is in need of attention. Fish and wildlife are more than an incidental resource, and adequate provision must be made to provide suitable environment to protect and increase the desired wildlife population including waterfowl, upland birds and big game.

The Tucannon River, a small tributary of the Snake, once supported large runs of Chinook, Steelhead and Silver Salmon. Depleted runs of Chinook and Steelhead occur at present. If these runs are to be restored, protective measures will be needed. There are also some trout of various kinds in the streams, lakes and reservoirs in this area and some of the lakes contain bass, bluebacks and perch. With the development of the Columbia Basin Project, new lakes and ponds will provide additional water that can be stocked with fish and waterfowl.

(Structural Measures Primarily for Flood Prevention)

Structural measures are needed to retard or control runoff so that it will pass through the minor waterways and tributary channels without overflowing bottom lands. They protect adjacent land from

erosion of unstable channel banks and beds and prevent damage to, or destruction of real and personal property and improvements. Valley bottom lands, potentially the most productive of the watershed, are often limited in use due to the effects of frequent or seasonal inundation.

The application of the recommended land treatment program to cropland, range land and forest land will result in the maximum retention of the rainfall in the soil consistent with the use of the land for production purposes. There will be some reduction in the rate by which the runoff will reach the waterways and tributary channels. These effects will result in a reduction of the peak flood flows, especially for the smaller, more frequently occurring storms. Sedimentation will be reduced as a result of applying these land treatment measures.

However, under the most favorable soil conditions resulting from good land management, the infiltration rates of the soils will be exceeded by the intensities of numerous storms and runoff will occur. Also, if the soil profile is already saturated, or if the soil is frozen, the percentage of runoff from rains and/or snow melt will be extremely high.

Runoff sufficient to cause damaging floods can result regardless of what the use or treatment of the land has been. Damaging floods will be less frequent and the flood peaks will be lower as a result of the application of the recommended land treatment program, but there will remain a flood problem that can be solved only by structural measures.

Structural measures used to prevent flood damages include water retarding reservoirs and channel improvements to provide for the passage of the flood flows without causing damage. Control structures are frequently required to stabilize grades and cross-sections of unstable channels.

(Administrative and Management Measures)

Chief among the administrative measures applicable to all kinds of land is that of planning resource development. Use and development of resources have been in considerable degree haphazard and unplanned, done according to current pressures without much attention to orderly and integrated arrangement of operations in regard to all resources of the land. This picture is changing as the importance of all the resources becomes increasingly emphasized. Thorough advance planning is now recognized as a primary step in resource management.

Other administrative measures are applicable more particularly to certain classes of land where specific uses have developed their own individual problems. On grassland, for example, exclusion of game and domestic stock becomes a management measure applied to permit regeneration of depleted ranges. On watersheds furnishing water for municipal use, a dead-animal patrol and other pollution control activities become management measures. In scenic and recreation areas, cleanup of unsightly debris from various activities, and the installation of recreation facilities are administrative and management measures.

Administration of forest land requires various measures to improve access and communications and to facilitate operations and

supervision. Roads and trails, aircraft landing fields, radio and telephone installations, buildings for personnel and equipment, water developments and sewage disposal systems, all are in the category of management aids. For fire protection, there are also included such things as tank trucks and strategically located water storage developments. Each resource use and each phase of administration has its own requirements of this kind to promote better management.

Surveys in the Program

Under this heading are included operations carried on to obtain data on which to base management practices. For management to succeed, a foundation of knowledge of all phases of the resource being managed is required. So management must have soil surveys, to determine the range of soil conditions with respect to fertility and productivity, stability against erosion, water absorption capacity, and other factors. In the same way, knowledge of climate must be gotten; this involves taking observations on temperature, rainfall, snow accumulation, wind, humidity, length of growing season, etc., at a network of stations for some items and by special surveys to determine effects of various factors for others. With regard to water, stream gages are needed to determine normal yields, and to evaluate management of timber and forage resources insofar as it may affect water. Aerial photos, topographic maps, and transportation maps also apply to all kinds of land, and are necessary tools of management.

Specific land classes have their own particular needs. Boundary surveys are needed to separate private and public land parcels, to

avoid trespass difficulties. Up-to-date timber surveys are needed on forest lands to show current volumes available for harvesting, and to help determine growth rates for establishing allowable cut. Forage surveys are needed on rangelands to locate critical areas, to determine range condition generally, to establish priorities for improvement measures, and to guide range use. Some of these are one-time projects, others are intermittent, still others are more or less continuous.

Surveys of a somewhat different kind are needed to determine effectiveness of management and its programs. These surveys may include parts of those listed above. In addition, such things as erosion surveys and sediment sampling will tell much about the quality of resource management. Big game censuses and insect and disease damage surveys help management define its problems and keep ahead of them.

Research

In a dynamic economy the progress of various segments of the economy are dependent to a large degree upon the adequacy and proficiency of research as well as the willingness of the people to accept and to adopt research findings. Research encompasses all phases of the problems--physical, economic, and social. Each phase of research, to be of practical value, is interdependent upon the other phases. For example, research findings on physical problems may have little practical value until research finds an economic use of the products of physical research. Research must prove that

the proposed solutions to problems are both physically feasible and economically sound. The whole research program is closely correlated and interdependent.

Education

Ultimate development of the agricultural resources of the Big Bend-Palouse-Lower Snake area is dependent upon the active participation of farm families, timberland owners and operators; and upon the cooperation between farm, forestry, civic and commercial organizations; local, county, and state institutions; and governmental agencies. Participation and cooperation can best be effected through complete understanding of the program, general agreement on the functions of all agencies, and the acceptance by both farm and forest people and governmental agencies of the responsibilities of each. This can be established best through educational means.

Credit

Implementation of the agricultural program herein described will, to a major degree, be dependent upon the availability of credit. If adequate amounts and kinds of credit are available to farm, ranch and forest owners and operators, the program can be established in an orderly, sound manner. If, however, adequate amounts and kinds of credit are not readily available it may be expected that the adjustments and program measures will not be installed as rapidly as envisioned.

<u>Definitions of Quantities, Conservation, Development and Use</u>

From the inventory of watershed conditions on the 10,000,000

acres of land within this area there has developed an appreciation of the problems and accomplishments of past generations of farmers, ranchers and lumbermen. Past use of land, whether for forage, tree, or wheat production combined with a growing concern for water use, has raised many questions regarding use of these resources. Some answers will be proposed in this report in the form of a program of activities conceived for the purpose of maintaining, developing or increasing the flow of products from the land.

Much has been done already to prevent erosion, increase crop and forage production, protect the watersheds and reduce flood damage. With these past accomplishments we are not concerned except as they contribute to our ability to solve the remaining problems and establish a rate of progress in their solution. Continuance of the present practices at the present rate of application constitutes a program by which many future needs will be met.

That the threat of impaired production should be removed before it becomes critical, a program of measures and practices developed for application within twenty years, except for some forest goals which require longer periods. This increased effort will require some additional appropriation of public funds and allotment of private money. This program is the sum of the measures recommended in the following sections of this report.

RECOMMENDED PROGRAM FOR CONSERVATION, DEVELOPMENT AND USE

Cropland

The goal in conservation of croplands is inseparable from the goal of profitable production. The production efficiency of thousands of farms can be increased through maintaining grass and legumes

on sloping land endangered by erosion when used for intertilled crops. To make use of more hay and forage requires that more farm operators develop skills and obtain equipment for handling livestock. Thus a new pattern of practices, skills, and land use is required to attain the indivisible goals of conservation and profitable production.

The program recommended for the 4,900,000 acres of cropland in the area at present, which will be increased to approximately 5,500,000 acres with the completion of the Columbia Basin Project, (approximately 1,088,000 will be irrigated), will encourage and assist farmers to put the land to its best uses. Some land now used for crops will be used for pasture and for woods while some of the land now used for range and non-irrigated grain will be developed for irrigated crops. Adapted crop varieties, improved production methods, rotations, insect and rodent control, weed control, fertilizers, and lime, all have their place in the conservation program.

Experience has shown that erosion cannot be controlled on some lands by good cropping practices alone. It will require concurrent use of terraces and/or field diversions, grassed waterways, gully control structures, and other measures. An improved conservation program is essential to foster the adoption of desirable practices in critical areas.

Practices for Soil Protection and Improvement

This group of practices which function primarily to prevent excessive erosion and aid in soil improvement includes all the contour farming practices, terracing, field diversions, field strip cropping, crop residue utilization, subsoiling, other tilling, green

manure and cover cropping, conversion seedings and plantings, rotation seeding, pasture seeding, pasture management, liming and fertilizing.

Contour farming is needed on approximately 2,800,000 acres in this area. This is farming slopes whereby plowing, planting, cultivating, and harvest operations in the production of field crops, and in orchards and vineyards, follow lines that are level or conform to accepted standards for grade. Farming operations usually are parallel to terraces, field diversions, contour strip cropping boundaries, contour planted trees or vinerows or temporary guide lines. Contour strip cropping, contour planting and all other cultivation operations performed on the contour to hold surplus water or dispose of it at non-erosive velocities are considered forms of contour farming. Practices of this type are required if cultivated crop production is to be maintained on a large part of the undulating and sloping lands. These practices will aid materially in reducing run-off and stabilizing the topsoil.

Terraces. Approximately 450 miles of terraces are recommended for construction on sloping and undulating cropland. The major portion are needed in Garfield County, Washington. Terraces are graded channels across the slope to intercept and control run-off and minimize erosion. The channels are constructed with supporting ridges on the lower sides and are laid out in a manner to permit them to be cultivated with the field. Gradient terraces, which will dispose of surplus water at nonerosive velocities are needed on impervious soils and level terraces which will hold available moisture on the

land are needed on the permeable soils. Terraces of proper design divide long slopes catching the water before it accumulates into damaging amounts. They encourage contour farming, and in general, maintain and increase crop yields. They are adapted for use on long slopes of less than 10% in the dry farming areas. Sodded waterways and protected terrace outlets are essential to a well designed terrace system.

Field diversions. Approximately 1,200 miles of field diversions are needed on the cropland in the area. The major portions of these are needed in Walla Walla, Columbia, Whitman and Garfield counties in Washington and Latah County in Idaho. They are graded channels across the slope, to intercept runoff water from upper areas or at regular intervals across cultivated areas. These channels are constructed with supporting ridges on the lower side and are not cultivated with the field. They are usually protected by vegetation. Field diversions are often used to divert the excess water from the relatively steep rangeland before it has a chance to sweep down across the cropland. They are also used on slopes that are too steep for terraces and as temporary protection for drainage areas while sodded waterways are being established.

Field strip cropping is needed on approximately 761,600 acres of the comparatively flat, light textured, dry farm lands in the area. The major portion of this land lies in Lincoln, Franklin, Adams and Walla Walla counties. This practice, primarily for protection against wind erosion, is applied by growing alternate strips of protective and protected crops. These strips run crosswise to

the prevailing winds. Protective crops may be small grain, stubble, planted legumes, grasses or native sod. These protect summer fallow and row crops. In light, sandy soils, strip cropping is an effective method of safeguarding summer fallow. The protective strips also help to hold snow and thereby provide moisture for subsequent crops.

Crop residue utilization is needed on approximately 3,912,000 acres. This is utilizing vegetative materials on orchards; vineyards and croplands, such as straw, stubble, prunings, and other crop residues, in such a manner as to reduce wind and water erosion, conserve moisture and improve the soil. It includes mixing the materials into the soil or leaving them wholly or partially on the surface.

Subsoiling is needed on approximately 407,400 acres of the cropland. Most of the land that requires subsoiling is in Lincoln, Adams, Garfield, Franklin, Grant, Douglas and Walla Walla counties in Washington and Latah County in Idaho. This practice is tilling the soil at least 18 inches deep to break up the plow sole, heavy clay subsoil, or a calareous layer which often forms in the subsoils of arid regions. This practice can be used to good advantage periodically on those soils that have a tight layer, not more than three feet below the ground surface, which restricts the passage of water and roots into the subsoil.

Other tilling is recommended for approximately 1,662,000 acres of the cropland in Whitman, Adams, Lincoln, Douglas and Franklin counties. These are the special tillage operations, such as basin listing, pit cultivation, contour listing, shallow chiseling (less

than 18 inches deep), rotary subsoiling and emergency furrowing, used to reduce erosion by forming basins or cracks in the soil to hold the water and permit the maximum amount to sink into the ground. This is primarily a dry land farming practice.

Green manure and cover cropping. Adapted green manure and cover crops are needed for the protection of approximately 1,125,600 acres of the cropland. Cover crops protect cropland from erosion when other crops are not growing on the land. This practice is planting annuals and biennials primarily to provide cover for erosion prevention on sloping land. When worked into the soil at an immature stage of growth they become green manure. The green manure practice is applied on both sloping and level land as a means of soil improvement. It includes crops grown in orchards during all or part of a year, or maintained over a period of years. It does not include the last crop of alfalfa or similar crop turned under for green manure.

Conversion seeding and planting is needed on approximately 213,100 acres of Land Use Capability Classes VI and VII land to effect a permanent change to more efficient land use. This is cropland which because of steep slopes, drouthiness, shallow depth, boulders, or subject to severe wind erosion, should not be cultivated. It should be seeded down to adapted grasses and legumes or planted to trees and kept permanently in pasture or woodland.

a. The seeding of perennial grasses and legumes is recommended for approximately 205,100 acres. (This item is included as reseeding in the range program).

b. The planting of forest trees is recommended for 8,000 acres on the higher elevation and hill tops in the eastern part of the Palouse River watershed.

Rotation seeding. The seeding of perennial grasses and legumes in a desirable crop rotation system is needed on approximately 1,885,300 acres of cropland. This does not include the annual and biennial grasses and legumes used for green manure and cover crops. Rotation seedings are effective in building up soil fertility and soil structure and counteracting the losses from soil-depleting crops. The legumes help to replenish the nitrogen and the grass and legume roots replace much of the organic matter which is broken down and used in the production of annual crops. Deep rooted legumes and grasses also bring to the surface plant food otherwise unavailable to shallow rooted crops.

Pasture seedings are recommended for approximately 480,100 acres. This practice is the establishment of forage plants for pasture, by seeding, sprigging or other methods. These are permanent pastures to be kept in as long as they are productive. When plowed out, this land will be farmed for one or two years to control weeds and undesirable species and then be reestablished to pasture.

Pasture management is needed on approximately 621,300 acres. This is maintaining a protective cover of vegetation in a manner which will increase forage, check erosion, restore or increase soil fertility and improve soil moisture conditions. It includes rotation grazing, proper stocking, fertilization, plant residue

accumulation, the mowing of pastures, the scattering of droppings and in irrigated sections the correlation of irrigation with other activities.

Liming is needed on approximately 6,000 acres of cropland that are deficient in calcium. The major need for this lime is on some of the irrigated lands in Douglas and Grant counties in Washington. Agricultural lime is applied to correct soil acidity and to promote the growth of soil improving crops.

Fertilizing. All of the cropland in the area requires or eventually will require the addition of some fertilizer materials to promote the establishment of soil-conserving crops, and to increase production. Fertilizing is the application of minerals or organic materials containing nitrogen, phosphorous, potash, sulphur, or minor elements to correct deficiencies in the soil, promote the establishment of soil-conserving crops and increase production. Separate estimates were made for the acres needing fertilizing to increase production.

Fertilizing to establish soil conserving crops is needed on about 54,000 acres. The major fertilizer elements needed for that purpose are nitrogen and phosphorus.

Fertilizing to increase production is needed on approximately 1,243,000 acres. There is a great need for fertilizer to get maximum production on the land that is being irrigated under the Columbia Basin Project in Grant, Franklin and Adams counties. Thousands of acres of this land, being broken out of sage brush is low in organic matter. The major elements needed to increase production are

nitrogen, phosphorous and potash. Sulphur and gypsum are needed mainly on some of the irrigated lands to improve the soil structure and counteract alkali.

Practices to Improve Drainage

The improvement of drainage on cropland is an integral part of a program for the full and efficient development, utilization and conservation of the lands of the area. Drainage promotes more efficient use of available land resources and permits a shift of crop production from highly erodible and less productive lands to those better adapted to continued intensive use.

Individual farm drains are those systems designed for the individual farm to remove or exclude excess water from the land and control the ground water level. Some degree of drainage is needed on approximately 86,400 acres in the area. The major portion of this land is bottom land in Grant, Whitman, Lincoln and Walla Walla counties. These individual farm drainage systems will necessitate installing 125 miles of closed drains deep enough below the ground surface to permit them to be farmed over, and constructing 300 miles of open ditches. These open and closed drains will require 150 structures such as inlets and outlets, flumes, drainage gates, pumps and drop structures to protect and improve the efficiency of the systems.

Community systems are those used by two or more farms as an outlet for the individual drainage systems. The amount of these community drains needed in this area is very small because most of the land requiring drainage lies along the "narrow" valleys where

the property borders on or is crossed by a natural waterway. The need for these systems will increase with the development of the Columbia Basin Project to take care of waste irrigation water or to take care of drainage problems that will develop with the irrigation of bench lands. Approximately 30 miles of new community drains are needed and 10 miles of the existing community drains need to be rehabilitated.

Irrigation Practices

Irrigation is essential to the fullest use of the lands of this area. With the completion of the irrigation developments under the Columbia Basin Project approximately 20% or 1,088,800 acres of the cropland in this area will be irrigated. The following practices are needed for the conservation and more efficient use of the irrigation water.

Preparing land for irrigation is needed on approximately 964,000 acres of the cropland. The major portion of this land is in Grant, Franklin, Adams and Walla Walla counties with a small acreage in Whitman, Columbia and Douglas counties. This practice includes grading or leveling of land in order to permit the uniform application of water in accordance with recommended standards. It includes surveying and occasionally consists only of floating or land planing to level out small surface irregularities of the land. Frequently it means moving large quantities of soil from one part of the field to another.

Improving farm irrigation is needed on approximately 30,000 acres of the cropland in Grant, Walla Walla, Columbia, Douglas,

Franklin and Whitman counties. This requires reorganizing, rehabilitating or replacing individual farm irrigation systems to improve irrigation practices. Some of the irrigation systems were laid out by the original homesteaders with ditches on improper grades or poorly located. Makeshift headgates and turn-out structures were the rule rather than the exception with a consequent difficulty of regulating irrigation water.

Improving water application is needed on approximately 1,059,000 acres of the irrigated cropland. The major portion of this land is in Grant, Franklin, Adams, and Walla Walla counties and will be irrigated under the Columbia Basin Project. The balance of the land needing this practice is in small irrigated areas in Douglas, Whitman, Columbia and Lincoln counties. This practice consists of improving the application of irrigation water in accordance with the soil type, water supply, slope, or crop requirements by adjusting the rate, amount and frequency of application. Proper water application is a major, if not the most important, irrigation practice in this area since over irrigation will leach the fertility of the soil, waste irrigation water, raise the water table to the point where it will cause a drainage or alkali problem, and reduce the quality and yield of the crops.

Improved trunkline systems are needed for approximately 8,000 acres of the irrigated cropland in this area. The major portion of this land is in Walla Walla County, Washington. This practice includes reorganizing, rehabilitating or replacing canals and structures distributing water to two or more farms. Many of the canals

or trunkline systems were developed through private initiative with problems ranging from an inadequate water supply to the lack of measuring devices on individual farms. Between these extremes are problems relating to diversions, headgates, canal relocation, canal lining, and structures such as siphons, flumes, drops, checks, and crossings.

New farm irrigation systems will be needed on about 14,000 farms, chiefly on the project lands.

Developing irrigation facilities. There are approximately 1,400 irrigation facilities needed in the area to supplement the existing water supply for irrigated cropland. Approximately 400 of these will be needed on presently irrigated land and 1,000 on irrigation development outside the Columbia Basin Project. They are located in Douglas, Adams, Grant, Whitman, Lincoln and Walla Walla counties. These irrigation facilities include reservoirs, springs, wells, pumps, flumes, control structures, measuring devices and other appurtenances for delivering water. They may involve new permanent storage reservoirs, small reservoirs for overnight storage, or other supplemental storage. There are many acres of land in this area that cannot produce maximum yields because of a shortage of irrigation water late in the season. It is on this land that every economically feasible facility to conserve, increase, or extend the irrigation water supply should be developed.

Miscellaneous Practices

Farm ponds. There is a need for an additional 1,350 farm ponds in this area. The greatest need is in Whitman, Garfield, Grant,

Lincoln and Columbia counties in Washington and Latah County, Idaho. These are small ponds or reservoirs for stock water, fish and wildlife, or for temporary supplemental storage. A few of these are existing ponds or reservoirs that need to be lined with impervious materials to prevent loss by seepage.

Correcting soil salinity. There are approximately 32,000 acres of alkali soils in Whitman, Grant, Walla Walla and Lincoln counties that need to be corrected. This practice includes treating the soil with amendments and organic matter to neutralize the alkali, or flooding and leaching to remove excess salts. The physical properties of the soil are greatly influenced by the degree to which the clay and organic matter are affected by sodium. As the sodium increases the soil structure deteriorates, the soil becomes tight or impermeable to water and air, the infiltration of irrigation water is retarded and drainage is difficult. Plants do not grow well in alkaline soil and are hard to establish because the relatively salt-tolerant plants like alfalfa and sugar beets are more sensitive to salts in the seedling stage.

Wildlife areas. There are approximately 26,400 acres of odd areas, field corners, field borders, ditch banks, pond embankments, and gullied areas where plantings can be made to increase the food supply and improve the habitat and cover for wildlife. In most cases these areas will be small plantings for the protection of game birds.

Liquid manure tanks are needed on approximately 60 of the dairy farms. These are tanks or pits to collect and store the liquid

manure, to prevent the loss of fertility, until such time as it can be spread on the cropland. They are needed on those farms where the cattle are confined to the barns at night or for a large proportion of the time.

Cleanup clearing is recommended for approximately 20,500 acres of cropland. This is cropland that has scattered stumps, tussocks, brush clumps, trees or rocks that should be removed to facilitate cultivation. It does not include the conversion of range and/or timber lands into cropland.

Controlling noxious weeds. The control of perennial noxious weeds is recommended for approximately 179,000 acres of infested cropland. This practice involves reducing the growth and density of noxious plants injurious to crops, forage, or livestock by cutting, tilling or applying chemicals. The most common noxious weeds in this area are bindweed (wild morning glory), Canadian thistle, blue flowering lettuce, Russian knapweed, cockle-bur, hoary cress (white top) and leafy spurge. Wild morning glory and Canadian thistle are found in every county. The infestation of white top and Russian knapweed is primarily confined to Douglas, Grant, and Whitman counties. Blue flowering lettuce is a problem in Grant, Lincoln and Whitman counties and cockle-bur in Adams, Grant and Whitman counties. Water hemlock is a problem on the wet cropland that is used for pasture in Grant, Whitman and Adams counties.

Fire protection. There are approximately 3,673,000 acres of cropland that need fire protection. This will require organizing and equipping 40 rural fire protection districts and crews and

establishing the necessary fire control units, equipment stations, guard lanes and other structures to provide adequate fire protection for the area.

Rodent control. There are approximately 240,900 acres of cropland that require a program to reduce the number of rodents injurious to irrigation or drainage structure, crops, forage plants and trees. The rodents that are a problem in this section are ground hogs or rock chucks, ground squirrels, pocket gophers, field mice and rabbits. Muskrats are also a problem in some irrigated areas. This program will include poisoning, trapping and similar methods.

Insect control is needed on approximately 80,000 acres of cropland to reduce the population of insects injurious to crops, forage and other plants. The insects that are causing the most trouble at the present time are grasshoppers, pea weevil, coddling moth and other orchard insects. This control will be accomplished by spraying, dusting, and poisoning or other similar methods where needed.

Windbreak and shelterbelt plantings. There is a need for 2,100 miles of windbreak and shelterbelt plantings. They will utilize approximately 10,500 acres of land. These plantings will vary from one to ten rows of trees and shrubs planted at right angles to the direction of the prevailing winds to lower their velocity and deflect them from the ground surface. This will reduce soil blowing, control snow drifting, conserve moisture and protect livestock, orchards, buildings, roads, and residences.

Flood Control Aspects of the Cropland Measures

The conservation land treatment measures for cropland, while primarily for the conservation, development and proper land use will also, with the exception of those applying specifically to irrigation, aid in the reduction of floodwater and sediment damage.

The recommended practices for soil protection and improvement will increase the intake of water into the soil, retard the run-off that is not absorbed, and lead the water, that is neither retarded nor absorbed, along the least damaging route to the major outlets. The measures to improve drainage will also help by providing an additional reservoir in the soil for absorption of precipitation. Thus the soil, through its increased capacity to absorb water, will act as a reservoir to reduce the overland flows and flood peaks in the waterways of the area. The combined effect of improved land cover and a smaller volume of run-off will reduce the silt load by holding it on the land and out of the streams, to lower flood damage significantly even without much reduction of flood flow. The volume of floods will be reduced by the amount of silt that is kept out of the streams. The total effect will be a one percent or more reduction in flood peaks accompanied by a 40% reduction in the tons of sediment carried by those floods.

Rangeland

(privately owned-non-forested)

The privately owned and operated nonforest range in the area amounts to approximately 3.6 million acres. These lands are large ranches in Adams, Grant, Franklin, Eastern Douglas, Columbia, Garfield

and Walla Walla counties. Small units of pasture lands in the east and north are intermingled with cropland and are used primarily for supplemental forage. The western range areas are in much larger blocks and are often intermingled with large areas of public range; this is particularly true in the arid portions of Grant, Western Adams, Franklin and Western Walla Walla counties. Integrated programs of management will be applied to public lands which adjoin privately owned range lands.

The goal for the recommended range program is to produce the maximum quality and quantity of forage on a sustained-yield basis. In addition to improving forage production the application of the recommended program will assist in flood control by waterflow retardation and soil erosion prevention. These goals can be brought about by conservation grazing of livestock on the land, using the range at the proper season in line with the growth requirements of the most desirable forage plants, obtaining as even distribution of livestock as practical on the range areas, and using types of livestock most suited to the forage types.

The recommended program is a group of conservation practices to maintain, correct, and/or improve the conditions and use of the land. These practices have been segregated into the four previously mentioned groups, namely:

1. Practices to improve and protect cover.
2. Practices having to do with livestock management in relation to the growth requirements of the most desirable forage plants.

3. Practices to improve livestock distribution on the range.

4. Land conversion from range use to a more appropriate use.

Practices to Improve and Protect Cover

Seeding and Planting. It is recommended that about 617,000 acres be seeded or planted to grasses, herbaceous plants or shrubs. This practice includes the establishment of protective cover where natural revegetation will not restore cover within a reasonable period of time or where unpalatable weeds and shrubs predominate. It does not include the seeding and planting of gullies and critical erosion sites.

About 1,468,000 acres of range are in "Poor Condition" and 604,000 acres in the lower half of "Fair Condition". Some of the lands in these two "Condition Classes" are suitable for reseeding to higher producing perennial forage plants, wherever a suitable seedbed can be prepared. On the nonforest range no land was considered for reseeding unless power machinery could be used.

It was estimated that only 424,500 acres in the above-mentioned condition classes are on range sites that are economically feasible for reseeding. This represents 19 percent of the "poor" and "low fair" range condition classes. This does not include lands which will be converted from range to irrigated cropland. These reseeded lands will have a livestock carrying capacity of over six times their present capacity in the "poor condition" class, and three to four times in the "low fair condition" class.

Although this practice is applicable to portions of all the counties in the area, the large blocks of depleted range lie in

the three most arid counties located in the western part (Grant, Franklin, and Adams).

Protective Fencing. About 300 miles of temporary fencing will be needed to protect new seedings on range lands until the plants become established. This practice does not include fencing for pasture management.

In Douglas, the north portion of Grant, Lincoln, Spokane, and the north portion of Adams counties, the major range site is known as the "channeled scabland". It is so named because channels were cut through the soil mantle to underlying rocky lava flows, leaving islands of soil in a sea of basalt. They vary in size from less than one acre to thirty or forty acres in the range areas (larger pieces of land are usually plowed up and farmed to grain). Where these areas have been abused and are in need of reseeding, it is necessary to protect them for a year or two with fencing.

Controlling undesirable vegetation. This practice refers to the elimination or effective control of poisonous, noxious, low-forage or nonforage competitive plants. It is divided into two parts, namely: (1) Sagebrush and other desert shrubs (Rabbitbrush, Greasewood, etc.), which are controlled or eliminated at relatively low expense per acre, and (2) Noxious, poisonous, or rhizomatous-growing plants, which are controlled or eliminated at relatively high expense per acre.

It is recommended that sagebrush be removed from approximately 377,000 acres of range land, located largely in the drier western portion of the area.

Approximately 50 percent of the nonforested range in Grant County, and 10 percent of the nonforested range in Franklin, Douglas, and Adams counties are covered with sagebrush; and it is estimated that on about 50 percent of this total acreage the unpalatable brush can be economically eradicated.

There are about 175,000 acres of rangeland on which noxious, poisonous or rhizomatous-growing plants should be controlled.

There are several species of poisonous, noxious, and rhizomatous-growing plants which are detrimental to the proper use of the range land or endanger the surrounding cropland with infestation. Some of the most numerous and important are morning glory (Whitman, Latah, Walla Walla, Lincoln, and Columbia counties) Canada thistle (Whitman and Latah counties), St. Johnswort (Spokane, Garfield, and Latah counties), Russian knapweed (Grant County), whitetop (Grant and Whitman counties), and water hemlock (Latah, Whitman, and Walla Walla Counties). There are other small localized areas of larkspur and death camas which have not been included in the data.

Water spreading and irrigation. Water spreading and irrigation is recommended for about 4,000 acres. Under this practice are included the construction of facilities to divert runoff water from watercourses or gullies and to distribute it through systems, not requiring manual operation, onto adjacent grazing lands; and the irrigation of nonarable lands having high forage producing capabilities.

The counties having the largest acreages on which this practice

would be applicable are Lincoln (1,300 acres), Grant (800 acres), Adams (600 acres), and Franklin (300 acres). Diversions to bench range land in Walla Walla, Columbia, and Garfield counties would also have localized importance.

Fertilizing. It is recommended that the 424,500 acres recommended for seeding and planting be fertilized (about 20 pounds of nitrogen per acre) to assist in the establishment of a vigorous and productive stand. These range lands in the lower condition classes which are recommended for seeding and planting are low in nitrogen and organic matter.

Proper Stocking. This practice is recommended for about 1,953,000 acres, or the balance of the range land on which proper stocking is not practiced at the present time. This management practice is the grazing of land at such intensity as will make proper use of available forage. Proper use rates will leave sufficient vegetation to control erosion.

This practice is dependent on range surveys for an inventory of the range forage type and range condition classes to set up an initial stocking rate, utilization surveys after the grazing period, and the final adjustment of management in line with these findings. This applies to all the range in this area, and has been established on about 40 percent of the private nonforest range.

Deferred Grazing. Deferred grazing is recommended on about 2,500,000 acres which is the balance of the range land on which it is not practiced at the present time.

Deferred grazing is the postponement of grazing through the growing and seed development period of the more important plants

to permit seed production, seedling establishment, the recovery of the forage plants.

As has been mentioned previously, approximately 70 percent of the rainfall in this area occurs during the late fall, winter, and early spring seasons, when the temperatures are too low for plant growth. The growing season, during that part of the year when temperatures permit growth, is limited by the amount of moisture that can be stored in the soil. During this limited growing season the plants must be given the opportunity to produce seed as well as forage. If a range is grazed heavily every year throughout the growing season the plants have no opportunity to produce seed and eventually the most desirable plants will be eliminated. A system of deferred grazing which allows alternate rest periods and grazing periods during the spring growing season permits the plants to produce seed at the necessary intervals and assists in the improvement and maintenance of the most desirable forage plants.

This practice applies to all the private nonforest range land in the area, and has been established on about 20 percent of the land. It applies, on the average, to about one-third of the range land acreage each year.

Exclusion. It is recommended that livestock be excluded from 606,000 acres recommended for seeding and planting for a period of at least a year. In some of the drier areas, two years of non-use is recommended to permit the new seedlings to become well established. Such dryland range grasses as crested wheatgrass and

beardless wheatgrass develop a root system rather slowly, and they are easily uprooted the first or second year by grazing animals.

There are other small localized spots of sand dunes, bedgrounds, etc., in Grant, Franklin and Walla Walla counties that should be excluded from livestock use, but their combined acreages are relatively small and were not considered.

Practices to Improve Livestock Distribution and Management

Water storage facilities. It is recommended that approximately 1,600 additional water storage facilities be constructed where they are the most practical and feasible method of providing livestock water. This practice is especially applicable in Grant, Adams and Lincoln counties because of favorable soil and runoff conditions. This practice includes the construction of livestock watering ponds, tanks and small reservoirs to provide water to improve livestock distribution and forage utilization. It also includes lining existing ponds and reservoirs with impervious materials and the construction of large ponds with supplemental flood storage capacity.

This practice is most applicable under conditions where no creeks or springs are available and the difficulty and expense of drilling a well are prohibitive.

Springs and seeps. It is recommended that approximately 1,060 additional springs and seeps be developed. The development of natural springs or seeps to furnish livestock water has always been an important practice in range programs. This includes necessary pipe, trough and storage facilities. Next to natural creeks and

streams, the most desirable type of water for range livestock is clean, fresh spring water. Well distributed springs, piped into concrete or metal troughs, are a valuable asset to any ranch. With the exception of Grant, western Adams, Franklin, and western Walla Walla counties, the area has many springs that could be developed.

Stockwater wells. It is recommended that about 600 additional well developments be made. With the exception of Columbia, Douglas, and Garfield counties, which have adequate stockwater supplies in creeks, streams, springs, and small lakes, all of the other counties need additional well developments. They are especially needed in Adams, Franklin and Grant counties where the annual precipitation is very low. This practice includes the digging or drilling of wells where other suitable facilities for livestock water are lacking and well development costs are not prohibitive. It includes necessary pumps, windmills, storage tanks, etc., but it does not include wells and attendant facilities at farm and ranch headquarters not contributing to better livestock distribution and range forage utilization.

Where there are no springs, where the runoff is very small or lacking, and where the soils are so rocky or light-textured that stockponds are impractical, there remains only about two methods of obtaining livestock water: (1) hauling to tanks, and (2) drilling wells. On most range sheep operations, where herders have to be with the animals continuously, water hauling has usually been favored; but where the pastures are large and used mainly by cattle, wells are preferred.

Cross and drift fencing. It is recommended that about 1,350 miles of cross and drift fences be constructed for the proper control and distribution of livestock. This practice does not include boundary fences. In order to set up a system of rotation, deferred grazing, to separate pastures of different seasonal uses, and to facilitate the handling of livestock on the range, internal fencing is necessary in all of the counties in this area. This practice ties in directly with the livestock management practices.

Driveways and driftways. It is recommended that about 110 miles of driveways and driftways be provided.

The construction of driveways are sometimes necessary to eliminate livestock travel from roads or to provide definite routes for livestock travel between roads and distant range allotments or areas. The construction of stock trails through rock, timber or other natural barriers can aid in obtaining better distribution of livestock and better utilization of forage or water.

On most of the private nonforest range no driveways are needed; the county roads are numerous in this area and are fenced along both sides for the most part. But there are some localized areas where stock trails are needed. Trails are needed in places to facilitate movement of stock to and from the Snake River up the steep canyon sides to the plateau above. Along the Columbia River to the west and north, in Grant, Douglas, and Lincoln counties, the problem is similar. In Whitman County the Palouse River has need for several short trails also.

Among the miscellaneous range measures important to the area are: fire protection (2,862,000 acres), rodent control (50,000 acres),

and insect control (51,000 acres). Fire control will require the establishment of approximately 25 districts with the necessary equipment and organization to combat fires as they occur.

Rodent and insect control might well be done in cooperation with crop land operators. The extent and damage of rodents and insects occurs in cycles. In the drier western area, years of rabbit and ground squirrel concentrations cause a depletion of the already scanty forage. Periodically, these rodent populations build up in Grant, Adams, Franklin, and Walla Walla counties. Ground squirrels cause the most rodent damage in the more humid eastern area. Grasshoppers are the main range insect but usually cause more damage to adjacent cropland. The most serious insect infestations on range land are centered around the irrigated areas along Crab Creek and the Walla Walla River. The range lands adjacent to valuable croplands serve as the laying grounds for these grasshoppers. After spending their early life on the green spring grass, they move to the adjoining cropland with its green crops after the range grasses dry up.

Practices to Effect Land Use Conversion

Converting to cropland. Approximately 473,000 acres of range land will be converted to cropland use as a result of the Bureau of Reclamation's Columbia Basin Irrigation Project.

An additional 4,000 acres could be appropriately converted to cropland largely in Douglas, Walla Walla and Whitman counties. There are small areas of grassland in all the counties which are

not going to be irrigated, but can safely be plowed and cultivated. Generally these lands are included in Capability Classes II and III. Many of them lie within large range blocks and are used as an integral part of a pasture unit; but, from the physical standpoint, they could be converted.

(publicly owned rangeland)

Objectives of the rangeland program measures applicable to public lands are to institute management practices for both livestock and game which will facilitate range rehabilitation, restore depleted ranges, and maintain the productive capacity of ranges now in satisfactory condition. A further objective is the control of flood-producing runoff and reduction of soil erosion losses. Any of the measures which will improve cover conditions will aid in reaching this objective.

The program involves physical measures to improve the land and its cover, protection of range resources from damage by fire, rodents, insects, and disease, and practices to improve the management of the livestock and game that use the range. Each measure described is a part of an integrated program for all ownerships aimed at attaining maximum yields of forage and best use of other resources on the grazing land.

Water spreading and irrigation. This practice consists of diverting flood runoff to meadows and lowlying ranges to increase forage production. It is recommended for 6,600 acres of U. S. Department of Interior land.

[illegible]

Seeding and planting. Seeding and planting of grasses, forbs, and shrubs as a means of restoring vegetation is recommended on lands now producing much less than their potential capacity. This measure will be applied only to lands so badly denuded that natural seed sources are lacking but where successful revegetation is reasonably assured. It is an important flood and sediment control measure where existing cover provides insufficient protection against accelerated runoff and erosion. Total needs amount to 53,900 acres. All classes of public ownership are involved, with state lands making up two-thirds of the total.

Fertilizing. Fertilizing rangelands is recommended for 2,300 acres where fertility deficiencies limit seedling establishment and forage productivity, and will for the most part be done at the same time as the seeding.

Water development. A total of 188 ponds, springs, seeps, and wells are recommended for watering livestock to improve stock distribution and forage use. These facilities are needed on all public ranges, but nearly sixty percent are for state lands.

Fences. For management purposes, to regulate forage use and control livestock drift, 301 miles of fence are recommended. More than half the mileage is on state lands, but the measure will be applied to all public range.

Driveways. Stock driveways and drfitways are needed to move cattle and sheep to and from the ranges, and to make passage possible through areas of dense timber or blowdown. Total needs amount to 45 miles.

Miscellaneous Facilities. The efficient handling of stock requires such structures as cattle guards, loading chutes, and corrals. A total of 107 of these structures is recommended.

Range Protection. Rodent control is needed to reduce populations of jackrabbits, ground squirrels, gophers, and field mice on 56,160 acres. Two-thirds of the area needing this work is Department of Interior land.

Insect control to reduce forage losses is needed on 40,870 acres, half of which is Department of Interior land.

Weed control to eradicate larkspur, deathcamas, whitetop, St. Johnswort, and other noxious and poisonous plants is needed on 8,100 acres. More than half of this area is Department of Interior land.

Fire control for range areas is covered together with that for forest lands in the section on forest lands.

Forest Land

The general objective of the forest land program is to develop and maintain application of the principle of multiple use of the forest land resource and its products of water, wood, forage, wildlife, and opportunities for recreation. This involves maintenance of ground cover adequate to provide soil stability and protection against erosion, in condition to ensure continuing flows of clean water with maximum natural control of flood peaks. It involves sustained yield management of the timber and forage crops, specifying essential utilization and management practices to safeguard and perpetuate productivity. It also involves rehabilitation of

areas damaged by fire, insects, disease, destructive cutting, and overgrazing. It involves further the correlation of management efforts by various agencies, guided by adequate research and sound long-term planning. In detail, it includes such things as development and renovation of overmature and decadent timber stands now inaccessible, salvage of timber damaged by various causes, controlling timber harvests so that production is maintained during the change from cutting old growth to cutting in young new stands, gaining and maintaining control of fire, insect, disease, and other damage factors within tolerable limits. It means, finally, overall development of the land and use of its productive capacity in harmony with long-range social and economic needs.

With respect to timber, the ultimate objective is attainment of 21.6 million cubic feet growth and production of usable wood each year, including 74.2 million board feet of sawtimber. With respect to forage on forest land and public range land, it is the attainment of 97,000 animal-unit-month equivalents on ranges to be maintained in good condition. With respect to game and other wildlife, recreational use, and water, it is not possible to set specific goals adequately. However, it is recognized that demands along these lines are constantly increasing; they have therefore been carefully considered and are included.

The program measures described below are primarily those concerned with timber production alone. Some of them, however, have associated benefits of equal value. Other measures that may be applied on forest lands, though not directly concerned with forest uses, are described in subsequent sections.

Planting Forest Trees. This includes the establishment or re-establishment of a forest cover for timber production and watershed protection purposes, either by direct seeding or by planting nursery stock, and applies both to reforestation of nonstocked areas and to interplanting thin stands to attain full use of the productive capacity of the site. Total needs are for 30,510 acres of tree planting.

Stand Improvement. This measure applies both to natural stands and to plantations. It includes thinning, weeding, and release to increase the rate of growth, and pruning to increase timber quality in selected crop trees. Thinning may be done by intermediate harvesting of merchantable but slow growing trees, by cutting to improve spacing of crop trees in the stand, or by controlled burning. Pruning consists of removal of the dead lower limbs over the length of the first log above the stump, to permit the growth of clear knot-free wood on this section of the tree. Total needs are for 46,900 acres of stand improvement.

Forest Insect Control. This includes aerial spraying or dusting, and treatment or salvage harvesting of infested trees, but does not include recurrent insect detection surveys. It is aimed at such pests as the spruce budworm and the pine bark beetle. Application of this measure is recommended over a total of 24,690 acres at the present time.

Forest Disease Control. This involves gaining control of various tree diseases which are causing excessive timber losses. Control measures include treatment of infected trees, eradication

of intermediate host plants, and special salvage harvest of damaged timber. Application is recommended over a total of 12,100 acres.

Rodent Control. Reduction of populations of porcupines, ground squirrels, mice, and rabbits is necessary to protect young natural stands of timber, plantations, and seeding areas. These animals in many instances are causing considerable damage to timber, and preventing the establishment of new stands either by girdling young trees or by eating the seed. Rodent control is needed over a total area of 43,000 acres.

Fire Control Improvements. This includes the construction of lookout towers, clearing of firebreaks, snag felling, disposal of slash and debris, and other work needed to reduce fire hazards and increase the efficiency of the fire protection organization. Total cost of all the various measures of this kind needed is $260,000.

In addition to the measures listed above, which are aimed at doing the work needed to put the forest resource in shape for better management, there are some regularly recurring measures that must also be applied. These measures have been grouped into three classes, as follows:

Fire Protection, Organization and Equipment. Included here are the costs for equipment, transportation, maintenance, and operation of Federal, state, and private forest fire protection organization. Total needs amount to $62,000 annually.

Management Measures. This includes the maintenance of satisfactory control of plant diseases and of insect and rodent pests, tree planting needed because of stand destruction by fire or insects or other agency, timber stand improvement in young stands

as they reach the proper age class for such work. These are the measures required annually after the lands have been put in satisfactory condition by the nonrecurring part of the program. In total, they will apply to 301,640 acres, and will cost $74,900 each year.

Technical Assistance. Services of trained foresters and other technicians are needed by small forest owners to help in applying good forest management practices on 76,300 acres. These services are provided by state and Federal agencies. Total costs will amount to $7,900 per year.

Measures not Associated with any one Kind of Land Use

Certain of these measures are aimed at stabilizing soil and reducing erosion, others at furnishing improved habitat for fish and wildlife. In the first class are such measures as dune stabilization, waterway stabilization, control of erosion and drainge on roads and trails, stabilization of slips and slides, and control of severe sheet erosion. In the second, such things as planting cover and food species, stream and lake improvement, development of waterholes, putting up fences, and building fish hatcheries are included. Both soil stabilization and wildlife habitat development measures are needed on all classes of land, and are integral parts of the program.

Food and Cover Plantings for wildlife are planned on 11,600 acres, all public land. Of this area, 300 acres on state land are in current projects. This work is needed to establish and stabilize

populations of partridge and pheasants, and to afford food for migratory waterfowl at their various resting plaßes in the area so that they do not attack farm crops.

Water developments for wildlife use are entirely on U. S. Department of Interior lands. They consist of dams to impound water for migratory waterfowl refuges, diversions, irrigation of food-planting areas, etc. A total of 65 are proposes. None of this work is included in current projects.

Fencing is included to control trespass, to protect forage and game animals, and to control movement of the animals. A total of 130 miles is recommended, all on Department of Interior lands, and all in the accelerated program.

Improvement of aquatic habitats is recommended for 50 miles of stream and 60 acres of lake. This work is aimed at removing blocks to fish migration, clearing out weeds and debris, providing shade along water edges, and creating resting pools in channels. The stream improvement work is needed on all public ownerships, and only 9 miles are included in current projects for state lands. The lake improvement is all on national forest land.

Hatcheries and rearing ponds are needed to build up fish populations to keep pace with growing demands and to restock streams where habitats are to be improved. Many streams that formerly supported local trout populations and spawning runs of anadromous fish have deteriorated because of heavy sedimentation and flashy irregular flow. With the program, it will be possible to restore good habitat and bring the fish back again. A total of 8 hatchery and

pond projects are included in the program. All are Washington state projects, and two are included in current programs.

In the soil stabilization and erosion prevention category, 1,135 acres of dune and blowout control are needed. None of this is taken care of by current projects. The bulk of the work recommended (1,000 acres) is on Department of Interior land.

Stabilizing Waterway Channels and Outlets. There are approximately 18,000 miles of waterway channels and outlets throughout the area that need to be stabilized and protected against erosion. This requires shaping the channels and outlets and planting 58,000 acres to a permanent vegetative cover. It includes constructing or installing 3,000 chutes, flumes, or riprap sections to aid in stabilizing the channels. The most of these installations are to stabilize critical erosion on the channels in Columbia, Douglas, Grant, and Whitman counties by providing permanent protection at points that cannot be adequately protected in any other way.

There are approximately 7,000 check dams needed for the stabilization of 5,040 miles of waterway channels. The major portion of these permanent type check dams are needed in Lincoln, Columbia, Whitman, and Walla Walla counties. The function of the check dam is to facilitate the establishment of vegetation and to provide permanent protection against erosion by slowing up the movement of water down the waterways.

Control of road erosion and drainage is needed along 540 miles of road. A little more than a third of the work is recommended on each of national forest and state owned lands, and the remainder

scattered over other public lands and the private forest lands. None of the work is included in current projects. So far as reducing erosion losses and stream sedimentation are concerned, this is one of the more important measures in the program. A large part of the contributions of stream sediments are derived from poorly drained roads and raw unstable road cut and fill slopes.

Stabilization of slips and slides is needed on approximately 1,000 acres of land. This includes the installation of toe walls, fences and other structures, with special plantings of vegetation. More than 80 percent of the work will apply to state owned lands.

Control of severe sheet erosion, beyond that which will be taken care of by other parts of the program is needed on 5,120 acres. About 85 percent of the recommended work is split equally between national forest, Department of Interior, and state owned lands, with the remainder applying to private forest lands. This measure involves contour furrowing and terracing, and must be done to enable reestablishment of plant cover on certain range and forest areas.

Structural Measures Primarily for the Prevention of Flood Damage

Principles

Flood damages can be prevented by reducing flood peaks with floodwater retarding reservoirs, by increasing channel capacities to accommodate flood flows or by a combination of these two methods. Storage possibilities, dam site conditions, damage types, downstream development, effect on downstream flood flows and relative benefits

of the two types of flood control are some of the features to be considered before a method of control is adopted. Where either method is adjudged possible, the final choice depends on which shows the greater margin of benefit over cost.

Permanent materials were recommended throughout the area with vegetated channels being so classed when used as adapted and properly maintained. It is not apparent that economic changes will limit the life of the proposed structures to a degree that would indicate that temporary construction should be used. All major structures are designed to pass a 100-year flood peak with channel design capacity based on a two to ten year peak depending on estimated effectiveness of the job for damage reduction.

The Recommended Program

Because the flood damage prevention measures were designed for specific sample streams and expanded to like streams a description of the program for each stream will describe the area program except for quantities and location. Table 2, Chapter V, shows the sample streams and character and extent of the problems involved. All the streams are in relatively low elevation zones resulting in rather frequent damaging flows combined with extreme variation in peaks. Two or three high flows of one season may exceed the annual peak of another season and the extremes result when weather conditions prevent runoff until the spring thaw, thus concentrating the winter precipitation into one large and rapidly developing flow.

Stream bank erosion, land scour and silt deposition are the principal damages from such a runoff. They indicate the types of

measures that might be effective and are the basis of the following sample stream programs.

Alkali Flat Creek in Whitman County traverses about 13 miles of good to poor producing flood plain, much of which is either wet or alkaline. The proposed measures consist solely of enlarging and deepening the present channel to provide drainage for the alkali areas and more rapid removal of flood waters. Extension of the drainage channels into alkali areas will be required in addition to the flood control job. This program is applied to a total of 65 miles of stream channel largely located in the Ritzville-Connell area.

Douglas Creek in Douglas County, and Missouri Flat Creek in Whitman County, are similar in problems and program so they are grouped together for convenience. Watersheds of both are devoted largely to wheat production with fertile flood plains where years of silt has gathered from the surrounding hills. These flood plains are generally too wet to crop to grain and too frequently flooded to plow, so a wet pasture culture has developed.

The proposed program is for straightening, deepening and clearing channels to provide capacities for two-year frequency peaks, with stabilizing structures as required to prevent the straightened channels from cutting deeper. Multiple purpose reservoirs could well be made a part of the development in either watershed and similar watersheds and should be investigated before project plans are developed.

The Orondo Fan in the west side of Douglas County is an example of a debris basin to protect orchard-planted fan areas from cloudburst storms. It has a 20-acre diked basin designed to hold the coarse material moved out of the canyon by heavy storms and to provide temporary storage for the water until it can be safely carried to the outlet drainage. The design storm of 100-year occurrence is 9,000 c.f.s. for which channel capacity should be provided.

This type of program is confined to the breaks of the Columbia River not because the cloudburst storms are limited to these areas, but because the development of orchards on the fans makes a high damage potential not found in other parts of the area.

Lower Union Flat Creek in south Whitman County and Swale Creek in Klickitat County are similar in many respects. Both are low gradient streams draining highly cultivated watersheds. The problem of late wetness is common to both although bank erosion is more prevalent on Union Flat.

Their recommended program consists of increasing the channel capacities to provide more rapid disposal of spring flood waters and an outlet for drainage. Some drainage benefits will result from the program without additional channels.

Willow Creek near Pampa in Whitman County was selected as a sample of program development to combat an advancing gully. It is similar to, but less severe than, Dry Creek in Walla Walla County and the remedy for both consists of drop structures to prevent further development. Retention of silt above the structures provides an opportunity to rebuild some of the lost land.

In addition to Dry Creek in the Walla Walla watershed, flood prevention programs were proposed for thirteen small watersheds which included twelve floodwater retarding reservoirs. These differ from other programs in the area only by the inclusion of the floodwater retarding reservoirs. Capacities of these basins vary from 200 to 1700 acre feet. With the exception of the one in Woodward Canyon it is proposed that they be provided with gates, making possible the storage of water for irrigation after the flood season is over.

Wilson Creek in Lincoln County provides a sample of control by means of reservoir construction having other uses that overshadow the flood prevention function. The greatest benefit to be derived from such a reservoir is that from use of the stored water for irrigation. Sixty of these are listed for further investigation because time did not permit further study at the time the survey was made. Irrigation needs, with occasional damaging floods in such confined areas as the Crab Creek and Lind Coulees indicate a need for multiple purpose structures. They would also become feasible programs in the Palouse, Walla Walla and Pataha watersheds when erosion is controlled on cultivated lands above reservoir sites.

All of the proposed measures for flood damage prevention are grouped under five headings, some of which include many types of work and materials.

Tributary channel improvements include clearing, enlarging, realigning, riprapping, vegetating, revetment and cleaning of debris. All are included as needed in the 473 miles of channel

improvement proposed. This does not mean 473 miles of construction are contemplated but that 473 miles of protected flood plain will result.

Closely allied to channel improvement, and in some streams inseparable from it, are the 395 waterway stabilization structures proposed. They are required to prevent deepening of watercourses into unmanageable gullies. They will also reclaim, by sediment deposition, some of the gullies now formed.

The construction of 22 floodwater retarding structures is proposed for the Walla Walla watershed and most of them will provide additional benefits from conservation storage for irrigation use.

Nine sediment detention basins are proposed along the Columbia River. They will serve as debris collectors to prevent damage to orchard lands on and near the fans built up at the canyon openings. Either a state or county highway crosses most of the fan areas included in the program.

Multiple purpose reservoirs. Reservoir storage capacity generally has values for other watershed purposes than flood control. The storage of water for irrigation is generally very important in the attainment of the full productivity of the watershed lands. Values for recreation and fish and wildlife provide additional justification for reservoir developments.

To plan a reservoir development to satisfy only one of these needs often complicates the later solution of the remaining water problems. The most efficient solution of all of the problems requiring water storage is generally to design water storage projects which provide for all water needs in multiple-purpose structures.

In some instances the full storage capacity of a multiple-purpose reservoir might be used for flood control purposes during the period of usual flood hazard and also be used to provide the required irrigation water by storing the late season stream flow when the period of maximum flood hazard has passed. In other instances it may be necessary to provide design capacity primarily for the storage of irrigation water due to the inadequacy of stream flow to supply the irrigation water requirements during the period when no flood hazard exists. Provision for a permanent pool in the reservoir could be made in deference to recreation and fish and wildlife requirements. The separate solution of a single water storage requirement may not be economically feasible while the simultaneous solution of all of the water storage requirements of a watershed, by use of multiple-purpose structures, may result in a very favorable benefit-cost ratio.

The total feasible program for multiple-purpose reservoirs was not determined due to limitation in survey resources. To evaluate all of the physical and economic factors associated with the determination of feasibility for all possible developments of this type would be impractical for inclusion in this report. Each possible development of this type should be investigated in detail as specific interest is expressed by those local groups that will benefit by its multiple-purpose functions. An operations program in this area should provide for investigation and planning of this type of project and establish a procedure under which those found feasible could be constructed by joint participation of those groups benefitting from such developments.

It is estimated that there are about 60 sites suitable for multiple-purpose reservoir developments in this area.

Administrative and Management Measures

These measures include preparation of resource development plans, improvement and extension of transportation and communication facilities, construction of buildings, installation of water and sanitary systems, development of recreation facilities, exchange of land to block up ownerships, and miscellaneous management facilities.

In addition to public land measures, the program also provides for technical assistance to private crop and rangeland owners to plan and install the land treatment practices and measures proposed (Table IV - 1). It is estimated that this assistance will cost about $8,000,000.

Resource development plans are needed for proper management of the area's resources. Among the more urgently needed plans are master soils and land use, water management, timber management, range management, wildlife management, recreation management, reforestation and forest protection plans including insect, disease, fire and rodent control. It is estimated that the development of these plans will cost about $184,000.

Transportation facilities needed include roads, trails, airplane landing fields, and helicopter landing spots. Construction or betterment of 340 miles of road is recommended. Three-fourths will be on national forest land. Similarly, construction or betterment of 335 miles of trail is recommended. Nearly 90 percent

is on national forest land. Three airplane fields and 31 helicopter spots are also recommended, predominantly on Federal lands.

Communication facilities include telephone line construction and radio installation. About 90 percent of the recommended program is for public lands, about half of it for national forests alone. Total needs include 61 miles of telephone line and 33 radio installations.

Primary purpose of the above measures is to improve forest protection and provide better management. Roads and trails, however, are also important in the development of recreation use. Access made possible by the roads and trails is to some extent necessary for carrying out other parts of the program.

For general management purposes, various kinds of buildings are needed to get personnel and equipment closer to the work and to replace present inadequate structures. A total of 99 buildings--dwellings, dormitories, offices, wareshouses, garages, and utility buildings are recommended. Accompanying the buildings, 21 water supply systems and 21 sanitray systems are also recommended. About 90 percent of these measures applies to public lands, primarily Federal.

To develop recreation facilities to meet growing demands, camp and picnic areas, shelters, miscellaneous facilities, and cleanup and disposal projects are needed. A total of 335 camp and picnic area units, two shelters, and four other facilities are recommended. All are on public land, with over 90 percent on national forest land.

Purchase or exchange of land to block up ownerships for better management and protection is recommended for 94,760 acres. This is entirely a public land project, and over 80 percent of the area is for the Department of Interior.

Miscellaneous facilities, grounds developments, and small structures are also recommended. About 5 percent applies to private forest lands, the rest to public lands, principally Federal.

Development of Program

In developing this program careful consideration was given to the experience of private land operators and those charged with the management of public lands. The results of research investigations within the area and in nearby but similar areas were also used as principal guidelines. General economic feasibility was weighed when benefits could be evaluated in monetary terms and in cases where this was not possible, intangible and general social benefits were considered. Other factors which were considered include the adaptation of necessary program measures to particular watershed characteristics in various areas and some alignment of certain phases of the program so as to better adapt them to generally accepted agricultural practice in the area.

Since proper land use plays an important part in the successful reduction of damages caused by floodwaters and sediment, close attention was given to measures which would provide benefits by retarding surface runoff and checking erosion.

Estimates of total needs were based on conditions existing in 1951 and the program was developed on the basis that the forseeable needs should be met within the next 20 years.

Procedure - Public Lands

<u>State Lands</u>. Program measures for state owned lands were developed essentially by state foresters and other state officials. U. S. Forest Service representatives first met with state representatives to acquaint them more fully with purposes, objectives, and methods of program presentation. Preliminary inventories of needs prepared by state officials were then compared with program estimates for similar and in many instances, intermingled Federal lands. This was accomplished in meetings of state and Federal representatives. Some adjustments were made so as to place both estimates on a comparable basis. Also, where available data on state lands did not permit compilation of a full and complete program, additional forest and range needs were developed by expansion from similar segments of Federally owned lands. State cropland needs were expanded from similar private lands.

<u>Federal Lands</u>. The program for National Forest Lands was built up largely from a field inventory made in the early stages of the survey by each district forest ranger with direct assistance from regional technicians. Administrative and management needs and some other measures of areawide application were developed by regional office personnel. The completed tentative program for the national forest lands of the area was correlated with like programs for national forest lands in other parts of the Columbia Basin.

Other Federal lands in this area which are included in the program are those administered by the Bureau of Land Management. The program for BLM lands was developed by that Bureau with frequent

consultation and assistance from U.S.D.A. technicians. Inventories of needed improvement recently compiled by the BLM provided a ready source of much of the needed information. However, in instances where data were lacking, needs for certain practices and measures were arrived at by expansion from similar lands under Forest Service or other ownership for which tentative programs had been compiled.

Procedure - Private Land

Cropland. The total conservation needs for croplands of the Big Bend-Palouse-Lower Snake area represents an inventory obtained by combining and coordinating information from several sources.

At county meetings of the ARC Program committees -- made up of representatives of the Production and Marketing Administration, U. S. Forest Service, Extension Service, Soil Conservation Service, and local farmers -- the conservation needs of each county were estimated as of 1951. These estimates were based on Production and Marketing Administration records of past practices, the county inventories recently compiled by the Soil Conservation Service and the experience of others. Coincident with that step, representatives of the Soil Conservation Service assembled similar data on conservation needs in meetings with Soil Conservation District boards, Soil Conservation Service administrators and technicians. Estimates so obtained were based on land capability and the conservation guides fitted to local conditions. They were made in terms of each land capability class needing a particular combination of practices and measures for each land use.

Because some practices are applied annually, some once and others at various intervals, a repeat interval factor for each practice was used to reduce all practices to annual terms. Using the percentage and repeat interval factors a table of conservation needs was constructed for each county.

At subsequent meetings attended by representatives of the Production and Marketing Administration, Soil Conservation Service, Land Grant Colleges, Agricultural Services, and the USDA Columbia Basin Field Committee, these two preliminary estimates were reviewed, adjusted, and combined into a single inventory of total needs for the croplands of the area.

Range Land. The recommended program for the privately owned range lands was developed in a somewhat similar manner, although several additional preliminary steps were necessary.

The area of privately owned range land was separated into five principal forage types: sagebrush and desert shrub, perennial grass and forbs, mountain brush, meadow, and annual grass and weeds. These lands were further classified into recognized and accepted condition classes. In this particular part of the analysis, existing range surveys were utilized wherever available. Where data were lacking, the necessary information was obtained on a county to county basis by expansion from samples or through reconnaissance. Appraisal of surface acre requirements or carrying capacity was included as a corollary part of these studies. Both condition classification and carrying capacity were discussed locally with workers and technical personnel of agricultural agencies in each county.

A preliminary program was then formulated for each county. After local review, the assembled conservation needs were finally reviewed in meetings with representatives of the Agricultural Resources Conservation Program Committee. Changes resulting from the advice and thinking of farmer groups and representatives of agricultural agencies were made.

Forest Land. Conservation and development needs for private forest lands were developed jointly by state foresters, other state land administrators and technicians of the U. S. Forest Service. In those instances where specific information was not available, program needs were obtained by expansion of program needs on state or Federal forest lands of similar nature and condition. In subsequent meetings between representatives of Federal and state agencies, the program for private forest lands was compared with those developed for both state and Federal lands and some adjustments were made in the kind and application intensity of specific measures. Also, the grazing measures applicable to private forest land were reviewed with representatives of the Soil Conservation Service and the Production and Marketing Administration.

Structural Measures Primarily for Flood Prevention. The quantities of structural measures required for flood prevention were estimated by the sampling method. All of the streams in the area having flood plains devoted to any type of agricultural production were examined with the objective of grouping streams having similar flood plain and watershed characteristics related to flood damages. At least one stream in each of these groups was selected as a sample

for detailed investigation as to the type and extent of flood damages and determination of the most feasible program to control these damages. The unit program data obtained for each sample were then assumed as applying to the total units of channel length represented by all of the streams included in the group for which the sample was considered as representative.

Flood plain and watershed characteristics considered in classifying the streams were (1) flood plain cover or use, whether cultivated, meadow, brush or forest; (2) relative texture, depth and salinity of the soil in the flood plain was used as a guide to its ability to produce; (3) types of flood damages experienced, including debris damage to irrigation structures, roads, etc.; (4) length and average width of flood plain; (5) of the watershed characteristics above the flood plain including soils, cover, slopes, etc.; and (6) apparent need for irrigation water.

Every flood plain now in agricultural production or potentially arable was inspected in making this classification survey. Canyons or other obviously unproductive reaches were not included in the channel lengths to which the data obtained from the sample stream investigations were expanded. The larger streams on which flood control measures may appropriately be applied by the Corps of Engineers were excluded from this survey.

The streams were classified into groups. One or more streams selected from each group provided samples for which flood prevention measures were planned in detail. Otherwise, similar streams, in some instances, were selected from widely separated areas where there was a probable difference in productivity.

Minimum necessary engineering surveys were made to obtain basic data for planning the structural control program for the sample streams. Stream grades were obtained either from U. S. Geological Survey topographic maps or, for short reaches, with a transit. Valley cross-sections and axis lines for dam sites, including channel cross-sections, were surveyed with transit and stadia.

Hydrologic studies to establish probable flood peaks and volumes of storm runoff were made. The basic data was obtained chiefly from water supply papers of the U. S. Geological Survey. Quantities and frequencies thus obtained were the basis for channel design.

The choice of control measures to be used was determined by evaluating the effects of each type of control on the particular stream problems. The types of flood damages being experienced and possible benefits other than flood control from water storage were basic considerations in making this determination.

The structural measures for flood damage prevention were then designed and the cost calculated on 1949 construction prices. Each sample stream program was evaluated against benefits with only those showing a favorable ratio expanded to the stream groups.

All the recommended structures are of a permanent (non-decaying) nature to reduce the operating and maintenance cost, and to prolong the period over which benefits may accrue. Vegetative control also was considered as a permanent construction material when used within its limitations.

Total miles of channel improvement and levees, and number of gully stabilization structures were obtained by expansion of the quantities as computed for the sample streams. The expansion factor was the ratio of total miles of channel in a group of streams to the channel miles in the sample which represented that group. This expansion by miles was made for each group whose sample program consisted of channel improvement measures.

Program Costs

All program cost estimates are based on 1950 prices for labor, materials, equipment, and other elements involved in the program. Total program needs are based upon watershed land and resource conditions as of July, 1951.

Table IV-B-1, included at the end of this chapter, summarizes the program quantities and costs for non-recurring measures (measures which require only a one-time installation, such as terraces, irrigation and drainage systems, capital improvements, etc.)

Table IV-B-2, included at the end of this chapter, summarizes the program quantities and costs for recurring measures (measures which have to be installed annually or at some other repeat interval as with cover cropping, contour farming, liming, fertilizing, etc).

The quantities and costs of measures primarily for flood prevention are included in Chapter V.

SURVEYS

Erosion Surveys

Information on the kind, areal extent, and severity of the past erosion, the present rate of erosion, the effects of erosion

on the various soils, and the susceptibility of the soils to erosion are needed, along with knowledge of the soils, climate, and other features of the landscape, in the planning of sound soil conservation measures. Certain reconnaissance erosion surveys have been made and other information on the kind and degree of soil erosion, or the condition of the soil resulting from such erosion, has been mapped in a part of the area as an integral part of detailed soil surveys.

The best and most economical way to obtain detailed information on the kind, location and degree of soil erosion over large areas is as an integral part of the detailed soil survey. Also, such a survey furnishes some information on the present rate of erosion, the susceptibility of the various soils to erosion, and the effects of erosion on kinds of soils. The costs of obtaining such erosion information are included in the costs of the soil surveys (see section on Soil Surveys) but not as a separate item. It is recommended that an inventory of streambank erosion conditions along small and large streams and river channels be made also as a part of the soil survey, and the costs of such are included therewith. However, erosion information additional to that ordinarily obtained in a detailed soil survey is needed on streambank erosion and the rate of sheet, gully and wind erosion.

Reconnaissance Surveys of Rates of Erosion

Data on rates of erosion can be obtained by several means, two of which are (1) making periodic surveys of erosion once every 5 or 10 years to determine the amount of erosion that occurred in

the interim, and (2) making spot sample surveys every season to determine the erosion occurring in the season by measuring the volume of rills, the height of pedestals under plants, pebbles, etc. On cultivated land where mixing of the remaining original surface soil with subsoil occurs during tillage operations or with soils whose horizons are indistinct, the amount of soil loss tends to be obscured. This tends to make less dependable the use of periodic surveys of erosion to establish erosion rates. In these cases the annual spot sampling method should be used.

The Soil Conservation Service, as a part of its regular activities, is now making surveys of the second type. In the course of these surveys, the results of erosion are observed in the field, and sample areas are carefully examined and measured. Based on these findings and on observations of areas where conditions are similar, maps are prepared showing areas of equal erosion classes, such as negligible, 5 to 10, 10 to 20, 20 to 50, etc., tons of soil loss per acre. To carry on reconnaissance erosion surveys on privately owned land during the 20-year program installation period, will require about 84 man-days or 4 man-months each year, at a cost of $500 a man-month. Total cost of the 20-year survey program will amount to about $40,000.

Similar kinds of erosion information on the public forest and range land are needed, although in general less detailed information is necessary, owing to the less intensive use of most of such land. Where not covered by soil surveys, a recheck of the erosion conditions or their resultant effects on the soils should be made

at about 10-year intervals. This may be done with 4-man days and a cost of $100.

Survey of Rates of Streambank Erosion

Rates of streambank erosion can best be measured by comparison of old and new maps or photographs of a watercourse. Base maps or aerial photographs are a prerequisite for determining soil loss by stream bank erosion for a specific stream. Loss rates can be determined by making new maps or rephotographing the stream concerned.

Data on stream bank erosion are necessary to determine the need for, and economic feasibility of, stream bank protective works, such as riprapping, revetments, etc. By using the above method to obtain information on soil loss, it is believed that such soil losses can be estimated along a given stream at a rate of 10 miles per man-day. Since the program proposed herein is planned for a 20-year installation period, the total miles of channel needing protection or improvement should be treated in the 20-year period. It would be necessary, however, to survey longer reaches of stream than actually need protection in order to determine the practical limits of the reaches to be treated. Probably twice as many miles of channel must be surveyed as there are channel miles estimated to need treatment. However, an estimated half or more of these miles of channels will be surveyed during the process of making detailed soil surveys, and the costs of these are included in the costs of the soil surveys. The total length of channel estimated to need protection, exclusive of rivers, amounts to 9,000 miles and the length of channel survey amounts to 18,000 miles. Assuming that

half the costs are to be included with soil surveys, the total additional survey cost in a 20-year period is about $22,700. A total of about 708 man-days will be required on this work.

Channel erosion surveys on public lands are also desirable, but they are considered a part of the job of planning location and extent of bank protection works. Later, when protective installations have been completed, periodic resurvey by means of aerial photographs will be needed to check on program effectiveness. To be done at 10-year intervals, this survey will require total labor requirements of 18 man-days and total costs during a 20-year installation period of $450.

Summary

A summary of the estimated man-days and costs required for the accelerated erosion surveys, other than that to be done as an integral part of the soil surveys, amounts to 1,710 man-days and $63,250.

Climatic Surveys

Information on the past climate and predictions on the future are important in many varied activities, but in this agricultural program only the part of the climate surveys that are significantly related to the agriculture or the development and use of the soil and water resources of the area are considered. Climate not only determines, to a large degree, the type of vegetation that grows naturally and the kind of agricultural production that is possible, but it greatly influences the formation of soils, governs the water supply and the occurrence of floods, and affects the activities of

man in many ways. The various elements of climate and weather vary greatly within the areas, and useful information on them is inadequate in several parts of the area.

Present Program

Over a period of several decades, many climatic data have been secured, chiefly in cities and settled communities, by the United States Weather Bureau and its cooperators and some stations maintained independently by others. The Weather Bureau, and to some extent other Federal agencies, now operate 36 standard and 16 recording precipitation gages and 32 temperature gages in the Big Bend-Palouse-Lower Snake watershed area.

Future Needs and Program Recommendations

Additional Standard Climatic Observation Stations Needed

Precipitation, temperature and other climatic data are especially lacking in unsettled areas and at the higher altitudes in the mountainous parts of the area. Sampling is inadequate and often misleading, where extreme differences are caused by marked topographic or other disturbances. Also, more evaporation data are needed at well chosen stations.

The numbers and types of the standard climatic observation stations listed in Table IV-3, taken largely from a list of stations recommended by the FIARBC in 1948, are needed in this watershed in addition to those now in operation. They are designed to improve coverage in the hydrometeorological network, improve flood warning services, improve operation of dams for flood control, irrigation, or power development, determine frost-hazard areas in greater

Table IV-3.--Numbers and estimated costs of installation and operation of climate surveys in the Big Bend-Palouse-Lower Snake area

Type of station	Number of stations	Installation cost: man-days	Installation cost: dollars	Annual operation costs: man-days	Annual operation costs: dollars	Total costs for 20-year period: man-days	Total costs for 20-year period: dollars
Precipitation 1/2/							
Standard	20	20	1,000	80	2,300	1,620	47,000
Recording	13	26	5,655	65	1,820	1,326	42,055
Temperature 1/	9	9	675	36	1,035	729	21,375
Evaporation 1/	2	4	870	16	410	324	9,070
Soil temperature 3/4/	3	12	3,060	21	600	468	16,140
Soil moisture 3/5/	6	36	1,695	42	1,200	912	26,865
Phenological Observation 3/		11	330	33	110	77	2,530
Soil freezing							
Mountain, forest and rangeland areas 1/	4	16	500	8	200	96	2,500
Crop and pasture land areas 3/	8	16	400	8	250	96	2,900
Total		150	14,185	279	7,925	5,648	170,435

1/ Costs are allocated to the Federal Government.

2/ Includes standard and recording precipitation gages for use in short-term small watershed studies in agricultural areas to test program effectiveness.

3/ Costs allocated half to Federal Government and half to respective states.

4/ These stations will be operated for a 5-year period, then moved to another site.

5/ These stations will be operated for a 10-year period, then moved to another site.

detail, and to improve soil management practices. The estimated costs are based on Weather Bureau station cost estimates.

Soil Temperature and Soil Moisture Surveys

Soil temperature and soil moisture influence most physical, chemical, and biological processes in the soil, and data on these factors and their interactions with the soils, plants, and animals are important in many environmental and other studies. Soil temperature and soil moisture, as soil characteristics, have been proposed as criteria to be used in the classification of soils. The successful use of such criteria will depend partly on the obtaining of sufficient data on these factors. Data on soil temperature and its correlation with air temperature are very inadequate for the various kinds of soils and associated environments. More data is available on soil moisture, but additional information is needed on the moisture content of specific kinds of non-irrigated soils throughout the year in relation to the climate, vegetation, and other environmental conditions. From a hydrological standpoint, information of this kind is very desirable for use in conjunction with soil freezing data and in determining soil moisture deficiencies at the beginning of the wet seasons. These factors may have considerable effect on flood flows and seasonal water yields.

Temperature and moisture recording apparatus for different (3 to 6) horizons of important soils in the several soil, climatic, and vegetation regions of this area are recommended to be set up. These soil moisture stations should be operated and maintained for a period of at least 10 years, but perhaps a 5-year period will be sufficient

for the soil temperature stations. Then the stations can be moved to other sites. The stations should be at or near standard Weather Bureau stations at which soil freezing and phenological studies are being conducted concurrently. Preferably, they should be at agricultural, range, or forest experiment stations, colleges, ranger stations, or other suitable locations. The sites should be carefully chosen on soils that are representative of important taxonomic units so that the results obtained can be extended to other areas of known similar sites. At first, the stations should be located according to the various soils, climatic, and vegetation regions, but two or three stations may well be in the same general vicinity but on different soils or environmental sites. Some of the stations should be at higher altitudes where most of the flood and seasonal water originate. Non-irrigated soils should be chosen for the moisture stations.

Three soil temperatures and six soil moisture stations are recommended for the Big Bend-Palouse-Lower Snake area. Their installation and operation costs are given in Table IV-3.

Phenological Observations

Observations and studies of Phenology, the relations between climate and periodic biological phenomena, are needed to improve the interpretation and analysis of climatic records for application to agriculture. To some extent, phenological data on orchard flowering, fruit setting, grain heading, and the like are now reported by cooperative meteorological observers. Critical observations such as these should be extended to a network of key stations in

agricultural areas, and the data should be organized and analyzed to provide seasonal occurrence maps similar to frost-season maps. This work could be handled by the Weather Bureau or by the Extension Service and the State Colleges. Installation costs would include developing the observation network and arranging for observations by cooperators. Annual operation and maintenance costs would include collection, compilation, analysis, and publication. Costs shown in Table IV-3 should be allocated half Federal and half State, with network distribution pro-rated to the various areas according to their relative agricultural land areas.

Soil Freezing Observations

Observations and studies of soil freezing, its location, depth, duration, and areal extent, are needed in hydrologic research as well as for improvement of soil management. In these studies, observations would be made on soil type, snow depth, soil moisture, frost type, and permeability of frozen layers at two-week intervals from mid-December through April. The studies and observations would be carried on for a 10-year period, by the Forest Service on mountain, forest and range land and by the State Colleges and the Agricultural Research Administration on crop and pasture land areas.

Estimated costs of soil freezing observations are given in Table IV-3.

RESEARCH

The research which is needed for the Big Bend-Palouse-Lower Snake area is also related with research that is carried on elsewhere in the Columbia River Basin Area as well as in other parts

of the country. The program which is proposed here cannot be carried out without giving consideration to similar research activities elsewhere. In this presentation, an attempt is made to present an over-all picture of research which is needed in this area. There is no implication that this research should all be carried on in this area. Some research which is carried on elsewhere will help to solve some problems here. In some cases, no additional research on a particular phase will be required; in other cases, only explorations might be required to determine the applicability of the findings in this area.

In presenting the research program, research which in general terms is applicable to all types of land--irrigated cropland, non-irrigated cropland, range, and forest--is presented first. Research which is applicable to all types of land varies considerably in detail from one type of land to another, although in general terms there is considerable similarity. For example, under water control measures, primary emphasis on range might be on systems of spreading water, while on cropland, emphasis might be on seeded water ways and strip cropping.

Following the section on research applicable to all lands are sections which include research which is applicable only to certain types of land. The combination of the two sections is the total research program for that particular type of land.

Research for all Lands

Physical factors of the various major soils which affect permeability, erodibility, aeration and water holding capacity should

be studied for all types of land. Some of these factors cause serious problems such as poor aeration and low infiltration rates. for irrigation water on clays and some soils high in silt, and excessive infiltration rates and low water-holding capacities on coarse-textured soils. In particular, the effects of cropping systems, organic matter additions, type and weight of tillage equipment, soil amendments, stabilizers, and drainage should be investigated with respect to these soil limitations. Considerable effort is warranted in developing equipment for rapid field determination of available water in soils.

Attention should be given to soil stabilization studies such as location, exposure, and gradient and width of roads in relation to erosion. The value of check dams, terracing and furrowing on the several slope gradients and exposures should also be studied. The possibilities for the use of erosion-controlling vegetation should be explored.

Principles and data on soil properties affecting their susceptibility to wind and water erosion are meager. Basic research on principles will aid in solving serious land management problems.

An expanded investigation program is needed to determine the fertilizer requirements of various soils. Particularly, research will calibrate soil or plant tissue tests with field response data so that each crop can more nearly attain the economic potential production. For cropland, this should include studies of the effects of crop sequences in the rotation, the amount and quality of water used for irrigation, the effect of land leveling, etc., and on

fertilizer requirements. This will also include developing better methods for determining fertilizer requirements of soils and plants.

Many phases of management of soils require more intensive research. Some of these phases are the time, rate and placement of fertilizers for various crops and the effect of cropping practices and rotations on soil properties, crop yields and quality and operators' income. Attention should also be given to soil moisture and crop relationships, crop rotations designed for soil improvement, use of minor elements and their effect on crop quality, the place of cover and green manure crops in erosion control, the effect of land leveling, and various other phases of soil management.

Studies of physical water control measures, as they may be related to streamflow, water spreading, and irrigation, require research. On range, research is also needed to determine improved systems of spreading water, types, kinds or species of vegetation best adapted, economic feasibility, and other features and the effect of these on range conditions. On cropland, the use of crop residues, terraces, diversion ditches, seeded water ways, strip crops, and crop sequence for the control and disposal of runoff water should be evaluated for the various soil types and rainfall areas.

Research should evaluate retardance characteristics of the grasses used in waterways, more particularly the bunch type and sod forming grasses which are used in the low rainfall areas. We also need a more thorough evaluation of permissible average water velocities and amount of stress that such grasses will withstand.

Hydrologic studies, including water cycles, should be conducted to determine the correlation between land condition on watersheds and peak flow, total water yield, soil temperature, density of vegetal cover, and soil type.

Breeding and testing programs should be set up to broaden the choice of crops, especially for substitute crops for those now in surplus; to produce new high yielding good quality winter wheats which are better adapted for early fall seeding for erosion control; to improve yield, quality, disease and insect resistance of c.o crops; to transfer needed agronomic characteristics, including resistance to diseases and insects, from related wild species to important adapted crops; and to produce varieties with desirable characteristics for processing. Evaluation of a wide range of crops and varieties of crops for various climatic zones and soil conditions with regard to yield, quality, hardiness, disease and insect resistance, erosion control and windbreak effect should be expanded.

Closely allied with this is the need to evaluate the processing characteristics of the various varieties of crops. The long distances and high transportation costs between this area and the thickly populated market areas of the United States make suitability for preservation by processing an essential prerequisite to the selection of kinds and varieties of crops to be grown in the area. This evaluation will be required before new varieties can be introduced. For example, before a new and improved disease resistant variety of wheat can be introduced, it must be shown that the milling and baking characteristics are acceptable. On new irrigation projects

this research is a prerequisite to determine kinds and varieties of fruits and vegetables which can be produced economically.

In the field of crop management more information is needed on time and rate of planting and seed treatments in relation to yields, disease and insect control. The best methods of establishing, maintaining or improving crops or pastures are not adequately known in the various climatic areas. Pastures, for example, are becoming increasingly important but many questions on kinds of grasses and legumes, their rates and dates of seeding, effects of fertilizers on yields and composition, carrying capacities and management to preserve longevity and desirable species composition for different classes of livestock need further investigation. On range, artificial revegetation is a useful tool in the rehabilitation of deteriorated land and similar research must be undertaken to determine what to plant, where to plant, when to plant, and how to plant.

There also is needed more reliable methods of evaluating various management practices.

Studies to determine the best means of controlling, by land management, cultural practices, herbicidal or biological methods, undesirable plants of the area are much needed. Some of the more serious problems arise from infestations of blue flowering lettuce, Canada thistle, morning glory, leafy spurge, Russian knapweed, white top, poverty weed, and Dalmatian toadflax on cropland and from St. Johnswort, medusa-head, big sagebrush, and rabbit brush on range. On cropland, losses from decreased yields or lowered

crop quality may be small or may amount to the entire crop in severe cases. Losses also occur from decreased livestock production and lowered quality of livestock products. On range, these plants reduce grazing capacity by crowding out good forage plants, and some are directly responsible for livestock losses through poisoning. Knowledge of the life histories and ecology of these species is needed as a basis for developing proper control measures.

Considerable losses are caused by insects and plant diseases to crops in the field as well as harvested crops. The diseases of plants, their morphology and ecology should be studied. Research on control of the insects and diseases is needed to insure more adequate protection. This should include research on control of soilborne plant diseases and insect pests by the use of crop rotation, soil fumigants and sterilants, and soil management. This should also include research on how to protect from damage by insects stored grains, feeds, and seed stocks as well as damage to various crops in the field. The relationship of land use to plant diseases should be determined. For example, observations indicate that overgrazed and weakened plants seem to become diseased more readily than properly grazed forage plants. The facts in this matter would be helpful in improving grazing management and increasing forage production. Soils also contain many types of beneficial organisms that may be injured by the control methods for pests, and this phase of the problem should be studied too.

Detailed knowledge of fire behavior, rate of spread, amount of heat released in a variety of fuels, under variations of climatic conditions and in relation to topography and elevation can be developed only through research. Such knowledge not only is fundamental to the development of efficient fire control organizations, but under

lies the use of fire as a management tool on various types of land and is basic in the development of range and forest rehabilitation practices for use following fire.

Research is needed to develop new and improved equipment for cultural practices, for harvesting crops, and for control of insects, diseases, and weeds.

Land and water resources of the nation are limited and the use of conservation practices is essential for the maintenance of the productive capacity of the resources. Considerable research is needed to determine the effect of various conservation practices or combination of practices on farm, ranch and forest organization, capital requirements, labor requirements, land use, crop yields, farm returns, etc. Research in economics of conservation is needed to determine relative income potentials under the various systems of land use, under varying degrees of conservation, and under various price-cost relationships. Evaluation should be made of the physical effects of different combinations of practices on soil loss, water loss and productivity retention. Income potentials should be projected by considering the relative productivity retention of the different combinations of conservation practices. An appraisal should be made of public benefits and other public aspects of different combinations of productivity conserving practices. Research would also ascertain the obstacles to and the problems involved in establishing and maintaining different combinations of soil conserving practices and analyze the different ways and means which might be proposed to bring about a socially desirable level of soil conservation.

A land operator is constantly faced with the problem of finding the best use of the resources available to him. The problem is concerned with both the combination of enterprises which the operator can undertake and the combination of the various factors of production with which he has to work. To assist the operator in attaining a high level of efficiency in his operation, research is needed to determine the best combinations of enterprises, the best combinations of factors of production, and other functional relations.

Research studies are needed to determine to what extent an operator can substitute one factor of production for another, what combination of factors of production will result in the least cost to the operator, what is the most profitable size for various types of farming or land use, and what are the advantages and disadvantages of specialization over diversification for the individual operator.

Operators are constantly meeting many uncertainties which affect the operation of his land and eventually the welfare of his family. These uncertainties arise from technological advancements, from weather, disease, pests, and other physical factors, and from changes in price relationships. Research is needed which will enable the land operator to meet and adjust his operations to these uncertainties.

Efficient use of credit has been affected by the continued trend in mechanization which has increased capital requirements. The increased investments in machinery and equipment are a significant part of the capital requirements necessary for an efficient operation. This development with changes in technology has raised

some basic questions with reference to adjusting production and operations to changing conditions. These high capital requirements and the availability of credit lead to greater inflexibility and specialization of operations and practices. Research in settled areas should be directed to determine the limits of efficient combinations of capital and labor on units of different sizes and different enterprise organizations and to determine costs and availability of credit to achieve long term, intermediate, and short term adjustments to efficient sizes and equipment.

Closely allied with credit is the need for insurance to protect the forest owner from losses arising from major risks. Research is needed to develop a feasible insurance program for forest land.

Technological innovations in the agricultural production and processing industries are primarily designed to increase the physical productivity of available manpower. New technological developments are constantly being advanced. Research should involve an economic evaluation of technological innovations to determine their impact on land use and industry. Their effects on the utilization and conservation of land and water resources should be considered. Specifically, this research would determine the effects of the adoption of certain technological innovations on farm planning--rotations, soil fertility and conservation practices, changes in the scale of operations, the effects on the rates of substitution of one product for another for the enterprise, and relationships between inputs in production prior to general adoption. Research should also determine the cost nature of technological innovations.

The mechanization of agriculture and the increase in land values have made the acquisition of an efficient unit with adequate equipment a difficult problem for the beginner without an outside source of capital. Changing technology and economic conditions have increased the amount of land which is needed for efficient operation and which can be profitably handled by one operator and his family. It is proposed that research be undertaken to analyze the economic problems in acquiring initial ownership of land, to analyze the economic problems associated with the acquisition of additional land, to describe and analyze social and economic problems associated with tenancy, and to evaluate economically ownership vs. tenancy. For range there is also the need to analyze the effects of various land costs on range management. For forest lands, research is also needed to determine the pattern of land ownership and the manner in which owners exercise and control their ownership rights.

The role of government in the development, utilization, and conservation of land and water resources has increased in importance in the last two decades. The economic effects of the many governmental activities have not been uniform for all farmers. Research is needed to determine the income effects of governmental policies on income stability, distribution of income in agriculture, and distribution of income between agriculture and the other segments of the economy, to determine the effects of governmental policies on resource development and utilization in agriculture, and to determine the internal consistency of domestic agricultural policies.

The agricultural economy of the area is dependent upon an efficient marketing system which will assemble, process, and move farm products to the areas of consumption. Research will be carried on to determine the type of marketing facilities which is needed and means of obtaining adequate facilities. The need for this type of research is greatest in newly developed areas in which there are limited marketing facilities. Research should also be undertaken to assist in the development of efficient marketing channels for each product at the predicted output at the state of full development. Research is also needed to determine the local, secondary and aggregate flow of agricultural products.

The new economic opportunities created as a result of water resource projects are significant for a research program in agriculture. Unless there is knowledge of what economic development will occur in the region during the next 25 years much of the research will be of little value. The types of markets, the degree of concentration of the population, the amount of income, etc., will determine to a large measure the type of farm enterprise which will be profitable for the farmers to follow.

By its nature the problem of the relationship of water and land resource development to general economic development of the area warrants serious consideration. There is need for a clearly defined or generally accepted concept of economic development to serve as a guide for directing future development.

As population-consumption habits change and as total agriculture production changes, the relative prices of the agricultural

commodities also change. These changes may lead to an inefficient use of agricultural resources because of the lack of knowledge as to the type and direction of the changes or the immobility of the agricultural resources. To guide efficient future resource use, research should be undertaken to determine the present production-consumption balance and resulting prices of the commodities of the Columbia Basin, Western Region and the nation and to determine the future production-consumption balance and resulting commodity prices that can be expected.

The orderly and continued development of the area to maximum economic productivity is dependent upon an adequate and efficient transportation system. Research should involve the analysis of the transportation structure with reference to availability and adequacy of types of transportation facilities at the points of origin and destination of the products transported, the evaluation of the present and potential productivity of the area and determination of the transportation facilities needed to facilitate the development of new areas, and the determination of adequate and efficient facilities necessary to maintain the utilization of the resources of the region in competition with other areas.

Another problem involved is to determine the extent, if any, of secondary benefits in the form of cultural growth which will accrue to the area as a result of water resources development. Research should determine the factors responsible for cultural growth and assess their relative importance and determine which of the factors promoting cultural growth are associated with the development

of water resources and the extent of cultural benefits which may be expected from such development.

Additional Research for Irrigated Lands

The complete research program for irrigated lands includes the research in the previous section, Research for all Lands, and research reported in this section. This section includes that research which applies *only* to irrigated land.

Among the many problems needing study are the irrigation water requirements of crops, the effect of irrigation practices on water requirement, amount of water lost by evaporation from the land surface during and after an irrigation, the amount of precipitation that is effective in reducing irrigation requirements, canal and ditch losses and economical ways of decreasing such losses, practical methods of reducing deep percolation and surface runoff and the effect of water cost on application methods.

The types of conveyance and distribution systems such as open ditches, pipelines, and flumes which are best suited in the various soils and farming areas together with their advantages and limitations, should be studied. Further evaluation of different types of wells, pumping equipment and power units and their adaptability to different conditions, their initial and operating costs and their life expectancy is badly needed.

Water management on the farm has been seriously neglected. On many of the steep rolling lands, erosion by irrigation water is excessive.

The installation of the farm irrigation system together with its operation and maintenance are greatly influenced by the method

used to apply the water, the cost limits for which have never been determined.

Engineering and economic studies on pipelines and ditch linings, including value of water saved, and decreased drainage costs are vital in improving irrigation practices on the farm. A measure should be made of the efficiency of applying water by the different methods of irrigation. The effect of slope, intake rate of the soil, crops, frequency and amounts of water to be applied by surface and sprinkler irrigation methods should be determined. The effect of size of stream, slope, length of run, shape and spacing of furrows on different soils should be evaluated and made the basis for developing recommended practices.

Serious drainage problems often develop when irrigation water is applied to the land. In the past, drainage has been largely a matter of trial and error. Instruments and investigational methods should be developed in order to obtain data relating to soil and water upon which effective drainage systems may be developed. At times, drainage may be practical only through the use of wells. In other cases, tile drains or open drains are best adapted. Criteria and limitations for the use of each should be developed.

Investigations on removal of toxic or excessive concentrations of salts, arsenic and boron and other materials by leaching, inversion of the soil, or conteraction by chemical amendments are essential.

Additional Research for Non-irrigated Cropland

In addition to the research applicable to all types of land, non-irrigated croplands also require the research included in this section.

Information is needed on the effect of shape and depth of channel cross section on accumulation of snow and ice during periods of alternate freezing and thawing. There is field evidence that structures with sharp bottomed, deep, narrow sections will carry water during periods of alternate freezing and thawing even though they may be completely full of snow.

Research is required to determine the permissible amount of deviation from contours, both as to percent of slope and length in strip cropping, without sacrificing effectiveness. The width of strip both for water and wind erosion needs evaluation. The effect of crop rotations for strip cropping should also be included.

Additional Research for Range Lands

This section, which includes research which is applicable to range lands only, and the section Research for all Lands form the proposed research program for range lands.

The effects of seed eating and forage consuming animals on forage production with particular reference to rodents and game animals should be studied to determine the need for the control of rodents and the management of game animals. The effects of trampling by large animals and earthworking by rodents on both composition and amount of forage by types in each of the condition classes should be analyzed.

Studies of the chemical composition of important native range plants and of species used for range reseeding are basic in the development of improved livestock nutrition and the solution of some management problems. Determination of fluctuations in the nutritive value of such species due to stage of growth, site, seasonal weather conditions, and other factors likewise are important in the maintenance of range livestock.

Research is needed to determine forage preferences, seasonal use, grazing patterns, and grazing capacity for both big game animals and livestock, and the interrelationship of joint use. Large increases in the deer and elk population point up the need for such studies. The effects of grazing practices and intensity of use on terrestrial and aquatic wildlife other than big game need investigation also.

Fundamental studies in the ecology and physiology of important range species, both desirable and undesirable, including annuals, perennial grasses, forbs, and browse species, are of high priority and basic to other research treated hereih. Also, studies of the ecology of the principal range types are of high importance. This fundamental research is needed to provide a base for improved range management practices and for the advance of knowledge concerning range condition and trend, artificial revegetation, and control of undesirable plants.

Range administrators and users generally agree that grazing capacity, rate of stocking, and other features of range use and management vary with condition or health of the range. Proper range

management then demands a classification of range lands as to condition and trend in condition and the development of standards for such classifications. Development of such standards and classification of range lands requires new ecological research for every major range type.

The major stumbling block to proper seasonal use is the imbalance in seasonal ranges. For example, a shortage of summer range as compared to spring and fall ranges and winter forage production creates an imbalance of range livestock operations. If livestock numbers are not adjusted then summer range is overutilized to the disadvantage of the land and forage resources. Imbalances can also arise if the rancher adopts practices which create surplus forage during certain seasons and if the rancher increases livestock to consume the surplus without developing a balanced seasonal program. Research is needed to determine the present extent of the imbalance in both physical and monetary terms, to determine the effect of a land treatment program on the imbalance between seasonal ranges, and to determine ways by which the imbalance can be alleviated economically.

Additional Research for Forest Land

Forest research in the area is directed primarily at solving problems in the management and harvesting of the tree crop. But it also is concerned with the interrelations of plant cover, soil, and climate as they affect or are affected by other forest land uses. Well rounded forest research must include investigations of water yield, flood potential, wildlife populations, and

recreational use and needs as well as studies in forest ecology, forest mensuration, transportation systems, and timber utilization. It must also consider grazing use of forest land by domestic stock and big game, and interrelations with other uses.

A basic phase of forest research is that covering ecology, silviculture, botany, genetics, and plant physiology, relating to the life history and characteristics of forest growth, the classification of forest species, the development of improved strains and hybrids, and to seed production and regeneration. Research in ecology deals with the interrelation and interaction of the forest plants with their environment. Research in silviculture includes studies of regeneration cutting, artificial reforestation, intermediate harvest cutting, and stand improvement. Genetics research is concerned with finding and developing timber trees with superior growth and form, greater resistance to insects and disease, improved timber quality, and adaptability to unfavorable sites.

Another phase is applied forest management research. Its objective is to test on cutting operations of commercial size the conclusions reached from small-scale studies in silviculture. Subjects for study include improved mapping and layout of logging areas, development of more efficient logging equipment, determination of lumber grade recovery from various species and grades of timber, relation of slash-burning for fire hazard reduction to soil conditions and timber regeneration, and the relation of silvicultural and logging practices to streamflow.

Research in utilization of forest products deals with use of

secondary timber species, defective timber and second-growth, as well as with the old-growth. It is aimed at finding productive uses for wood now left unused in the forest or in sawmill slab piles. It involves finding controls for rot and weathering losses, developing better methods of seasoning lumber, improving the yield and quality of pulp wood and of pulp and paper products. It includes also the design of improved wood and fiber containers, the determination of properties and uses of glues in the production of plywood and laminated timbers, and studying the properties and application of paints and preservatives. An important part of the work is the development and trial of improved milling equipment and methods to reduce wood waste.

As forest lands are the principal source of water supply, forest research also deals with watershed management. Studies in this field include the determination of the effects of various cover types and conditions on quality and quantity of the streamflow produced, of various land uses and management practices on flood occurrence, erosion, and sedimentation; the development of methods for soil stabilization, for prevention of soil erosion, and for restoration of forest cover. Providing basic data for such studies involves measuring precipitation catch and streamflow runoff on small watersheds where different land management practices are tested and compared.

In forest protection, research includes studies of fire behavior, disease and pest control, brush eradication methods. These studies are aimed at less costly and more effective production;

and involve developing and testing methods, materials and equipment, determining causes of damage, and assaying means of prevention. Reduction of fire hazard by slash-burning requires study to determine the nature and extent of possibly adverse side effects on soil conditions. Chemical methods for disease and insect control need checking to determine possibly adverse effects on wildlife.

Research in forest measurements is concerned with determining volumes of forest products, individual trees, and tracts of timber, and the rates of growth of timber, toward predicting forest growth and allowable harvest to maintain highest rates of production. It includes studies of lumber recovery from logs, of mortality, of growth response to thinning; and considers effects of such factors as stand density, age, vigor, and site quality. It determines the most effective means of measurement, and how they may best be applied.

Because the forest lands are the habitat for many forms of wildlife, including several game species, forest research involves wildlife studies. Subjects concerned include the effect of artificial forest openings on forage production for game, the effect of removal of forest shade on aquatic life, and the control of animal populations that may damage forest regeneration and soil stabilization plants. Toward multiple-use management of forest lands, information that will help improve integration of all resources is necessary.

Economics research has certain special applications to forest lands. The pattern of ownership affects the type of management

exercised; studies of ownership trends and management practices are needed to shape long-range development plans and legislation for effective management programs. Practical forest insurance needs to be worked out, to cover risks that are increasing with land and timber values, and to reduce the influence of risk in undesirable forest management practices. A forest credit program is needed to stabilize forest industry and to promote adoption of progressive forestry practices. Special transportation, distribution, and marketing problems need attention. The principal raw material--timber--is geographically widely dispersed, varies greatly in quality, is heavy and bulky, contributes to hundreds of manufactured products, and involves hundreds of independent businesses. Finally, the development of the basic resources of forest lands are strongly influenced by fluctuations in economic cycles. Price-cost relationships, labor supply, markets, and taxes govern the extent of conservation, use, and development of the forests; studies of past effects of economic changes are needed to provide direction to future developments.

PROGRAM OF EDUCATION

Educational Needs

There must be general public understanding of the development proposals and appreciation of the possibilities for increased income and improved living standards. People must realize that some adjustments in farming, range use, and forest land management can and should be made to maintain the lands and protect the public interest in their continuing use and productivity, and public investments in

new dams, reservoirs, and other structures, to insure their full and efficient use over a long period of time.

Educational needs are of three types: (1) to develop leadership and community organizations; (2) to assist farmers, ranchers, and forest and woodland users to understand and adopt a wide range of new techniques of soil and water conservation and management; and (3) to assist farm people to realize better living standards and farm efficiencies.

The anticipated scale of development in the program will make more acute the shortage of technically trained people to serve the various agencies and organizations that will be involved. Colleges, particularly in this area, should be aware of the unlimited opportunities such an important program affords properly trained graduates.

Program

In order to contribute to meeting these and similar needs, the United States Department of Agriculture recommends the development of educational and service programs to be carried out with the cooperation and assistance of federal, state and local agencies.

The benefits of the area development can be realized in full only if such educational efforts also include a program to improve living standards.

Conservation in Farming and Range Areas

The main objective of the educational program is attaining full application of adapted soil and water conservation practices.

Education must encourage the adoption of management practices which add to the material prosperity of the area. Improperly managed or abused, these resources constitute a liability. Soil and water

management for economic production calls for readily available information on the proper use of crops and practices which research and experience have proved best.

Education in proven methods of reducing and preventing water and wind erosion should be accelerated in keeping with other phases of the area development. Special emphasis is required in many critical erosion areas.

Drainage

Approved techniques of draining lands should be translated into farm and range practices, fitting local conditions and problems. Conditions to be corrected include the inundation of valley floors when floods overtop stream channels, runoff (including irrigation) from higher farm lands, and inadequate drainage caused by variations in topography and by lack of provision for proper drainage systems in irrigation projects.

Irrigation

The development program will bring about 1,000,000 additional acres of land under irrigation, and some farmers will need to learn a new type of agriculture. Many of these farmers may need to adjust their present dryland farming to irrigation or to combinations of dry land and irrigation.

The educational program in areas to be irrigated is designed to meet the needs in three stages of development: (1) Planning and preconstruction; (2) development and settlement; and (3) the post-development period.

The first stage will bring to the people information on the

latest research and the experience of irrigation farmers concerning the adaptability of the area for irrigation, probable cost and benefits, and adjustments in farm and living situations, as well as probable market outlets.

The second will supply more detailed information on soil-and water-management problems, water requirements of major crops, market outlets for new products, and problems of farm management and home management under irrigation farming situations.

Educational work in the third stage of development is particularly important in order that the whole community may fully utilize the opportunities for a balanced and more stable agriculture and better living. The farm people of these areas should be kept abreast of improvements in varieties, farm management, marketing and other forestry, farming, and homemaking practices which are developed by the expanded research program.

Assistance on small projects, as well as on large ones, is needed. These small projects, many of which are already established, involve many of the problems inherent in major projects and have some additional problems peculiar to small enterprises. These include poor distribution systems, incomplete land development, limited supply of water, inadequate maintenance, and the need for technical services in organization, finance, legal procedures, and engineering.

Supporting Programs

Of great importance is the job of supplying information concerning supporting programs of research and credit. The research

program will continually make new information available. This will be disseminated through the educational program to farm and forest people and other interested parties as rapidly as available. Farm people will be assisted in applying research findings to their particular problems, as will owners of timber land. Educational work in relation to credit will familiarize farmers and ranchers with sound credit practices.

Community development can only be achieved by the development of leadership and through adequate organizations.

Assisting People to Realize Better Living Standards and Farm Efficiencies

The use of electric power in practically all rural communities has and is bringing new conveniences to farm families. Where electric power is just becoming available, particularly on new projects, families may need information on bringing water into the house, sewage disposal, electrifying the farmstead, telephones, and the selection and care of electrical equipment.

Increased industrialization will come about as new electric power is available. Expansion of industrial centers will provide more local market outlets for farm and forest products. Equally important is that industrial expansion provides an additional outlet for employment of farm youth. Also the cost of developing and servicing improved health centers, recreational centers, and educational facilities will be shared by both rural and urban people.

Many families are now requesting help in planning new houses, remodeling old ones, or reorganizing the farmstead. Local

production of fruits, vegetables, and other food products will provide a more adequate diet. Better health will result.

Education Methods

Educational programs will be planned with rural people in their own particular areas and with representatives of agencies cooperating in the agricultural program. It is important that all available means be utilized to provide information and educational assistance to the rural groups to be reached as well as to the public as a whole.

Very effective educational work that is fundamental and of great potential benefit is that done with the children and younger people.

Wise use of conservation information in the seventh and eighth grades in grade schools, adapting future farmer training in the high schools to the development program, and the organization of 4-H Clubs along these lines will greatly facilitate the basin agricultural program.

Personnel Requirements

There are now cooperatively employed with the Federal government land-grant colleges and the county governments in the Big Bend-Palouse-Lower Snake Area some 14 men and women giving practically full-time to educational programs concerned with improving agriculture and homemaking practices. This staff in most instances is fully employed with current programs. The accelerated educational program here recommended will require about 27 additional personnel including county agricultural agents, home agents and

specialists at an increased annual cost of about $300,000. These additional persons will be required gradually as the program develops over a period of years.

The first specialists employed should be in technical fields which will contribute most to the irrigation and erosion control features of the program, such as agricultural engineers, soil specialists, and foresters.

Agricultural agents should first be added in counties where erosion is critical or in areas where new irrigation projects are being developed. They should be gradually added in other less critical areas where the present staff are unable to carry the accelerated load and where impacts of the various phases of the development affect the farm economy and living standards.

County home agents will be added first where new developments affect the living situation, particularly with respect to housing, use of electricity in the home, and where there are problems of living costs in relation to farm income during and following the development period. The additional staff recommended will be supervised by the present supervisory staff and housed in present county offices where possible.

Extension education as currently operated is financed largely by state and county funds with about 50% supplied in the area from Federal sources. It seems proper that any accelerated educational program should receive increased Federal funds comparable to appropriations to other phases of the accelerated program.

It is recommended that the Secretary be authorized to carry out with the land-grant institutions in the states of Washington and Idaho the educational program outlined herein.

CREDIT

Types of Credit Available

Life insurance companies and the Federal Land Bank system are the major institutional lenders to farmers seeking long term loans secured by first mortgages on farm real estate. Long term loans are available through the Farmers Home Administration to farm families who are unable to secure satisfactory credit at repayment terms which would enable them to finance major adjustments in their farming operations. Private individuals account for a large proportion of the lenders in the farm mortgage field., Usually they are less exacting than institutional lenders as to terms and purpose.

Commercial banks are of major importance in the short-term credit field. They also make available substantial amounts of credit when secured by real estate. Few restrictions are placed on use of funds, once a credit rating is established. The Farmers Home Administration also makes short-term and intermediate term operating loans for the purchase of machinery, livestock and other farm operating purposes.

The Production Credit Associations, charted under the Farm Credit Administration, makes short and intermediate term loans to members for farm operating and development and livestock purchase purposes.

Credit Problems and Needs

Credit problems and needs will be particularly acute in the Columbia Basin Project area. Adequate long-term credit for farm development and improvement in new reclamation projects is generally not available until the project has been in operation for a period of years. Lack of adequate credit with suitable repayment terms often results in low standards of living for the farm families during the development period. In addition, irreparable damage to the land resource occurs when adequate funds are not available to provide proper protection and use during development.

Intermediate term credit for purchase of foundation livestock, major machinery and equipment or for installation of conservation practices is often not available unless secured by farm real estate.

Timber owners have heretofore been unable to obtain credit for improvement and management of forest properties. Public Law 285, 83rd Congress, 1st Session, amends the Federal Reserve Act to permit loans up to 40 percent of the appraised value of merchantable timber on managed tracts offered for security.

Credit needs during the period of program installation are difficult to determine. Many complex, inter-related factors have a material bearing on the type and amount of credit needed at any given time. Such factors include the economic status of the nation, rate of population increase, whether the nation be at peace or at war, and the rate at which needed measures are established or when water becomes available for irrigation purposes.

The present and foreseeable economic level of the nation indicates that credit needs for farm development and improvement will be on a continually expanding basis. Credit needs for this area fall into three major categories: Long-term credit for farm purchase, farm buildings, irrigation or drainage, reforestation or range improvement, and farm development; intermediate term credit for installation of conservation practices and purchase of foundation livestock or major farm equipment; and short term credit for annual farm operation.

TABLE IV-B-1 Quantities and Installation Costs - Non-Recurring Measures

For Public & Private Lands In Big Bend-Palouse-Lower Snake

Measures	Unit	Total Needed Program Quantity (Units)	Cost (Dollars)
CROPLAND MEASURES			
Soil Protection and Improvement			
Contour stripping and planting	Acres	1,122,500	1,178,600
Terracing	Miles	450	45,400
Field diversions	Miles	1,200	237,400
Field strip cropping	Acres	761,600	228,500
Drainage Improvement			
Individual farm drains	Acres	86,400	647,600
Community systems	Miles	30	125,000
Irrigated Land Treatment			
Preparing land for irrigation	Acres	964,000	53,020,000
Improving farm irrigation systems	Acres	30,000	600,000
Improving trunk line systems	Acres	8,000	80,000
Developing irrigation facilities	No.	1,400	1,400,000
New farm irrigation systems	No.	14,000	70,000,000
Miscellaneous			
Farm ponds	No.	1,347	1,347,000
Wildlife areas	Acres	26,400	2,092,200
Liquid manure tanks	No.	60	120,000
Cleanup clearing	Acres	20,500	205,000
Weed control	Acres	179,000	1,253,000
Fire protection	Acres	3,673,000	202,000
Rodent control	Acres	240,900	361,300
Insect control	Acres	79,600	557,200
Windbreak & shelter belt planting	Acres	10,500	367,500
Clearing forest land	Acres	500	20,000
RANGE RESOURCE MEASURES			
Cover Improvement and Protection			
Seeding and planting	Acres	670,900	6,380,300
Protective fencing	Miles	310	108,800
Sagebrush & other woody plant control	Acres	377,600	1,132,400
Water spreading & irrigation	Acres	10,600	205,000
Fertilizing	Acres	426,800	2,168,500
Management Improvement			
Exclusion	Acres	606,000	0
Improvement of Livestock Distribution and Management			
Water storage facilities	No.	1,800	872,400
Springs and seeps	No.	1,100	318,500
Stockwater wells	No.	600	900,000
Fencing	Miles	1,650	1,182,500
Driveways and driftways	Miles	160	57,450
Misc. stock handling facilities	No.	110	79,900
Miscellaneous			
Rodent control	Acres	106,000	69,300
Insect control	Acres	91,770	82,270
Weed control	Acres	185,240	1,137,270

TABLE-IV-B-1 Public & Private

Measures	Unit	Total Needed Program Quantity (Units)	Cost (Dollars)
FOREST RESOURCES MEASURES			
Management Improvement			
Planting forest trees	Acres	30,510	1,070,750
Improvement of stands	Acres	46,900	940,500
Forest Protection (except fire)			
Insect control	Acres	24,690	244,860
Forest disease control	Acres	12,100	522,220
Rodent control	Acres	43,040	21,820
Fire Control Improvements(protection)	Dollars	- -	260,050
MEASURES NOT ASSOCIATED WITH ONE LAND USE			
Fish & Wildlife Resource Measures			
Cover and food plantings	Acres	11,590	164,910
Water developments	No.	65	1,763,000
Fencing	Miles	130	130,000
Habitat improvement-streams	Miles	50	29,370
Habitat improvement-lakes	Acres	60	1,530
Hatcheries and pond projects	No.	8	288,000
Other			
Stabilizing dunes and blowouts	Acres	1,135	254,000
Stream pollution control	No.	- -	- -
Stabilizing waterways and outlets	Miles	18,000	2,314,450
Erosion and drainage control on roads and trails	Miles	540	201,700
Stabilizing slips and slides	Acres	1,000	200,000
Severe sheet erosion control(public)	Acres	5,120	254,900
ADMINISTRATIVE & MANAGEMENT MEASURES--			
Technical Services(private crop, range)	Dollars	- -	8,077,758
Resource Development Plans	Acres	9,110,800	183,810
Transportation Facilities			
Roads	Miles	340	5,847,000
Trails	Miles	335	318,400
Airplane fields	No.	3	100,000
Helicopter spots	No.	31	7,600
Communication Facilities			
Telephone lines	Miles	60	68,000
Radio installation	No.	33	30,500
Buildings			
Dwellings, dormitories and misc.	No.	35	450,000
Offices	No.	6	47,800
Warehouses, garages and utility	No.	57	260,180
Water and Sanitary Systems			
Water systems	No.	21	95,100
Sanitary systems	No.	21	67,000
Recreation Facilities			
Camp & picnic areas - family units	No.	335	247,800
Shelters and bath houses	No.	2	11,200
Winter sports areas	No.	- -	- -
Misc. recreation facilities	No.	4	4,000
Clean-up and disposal projects	No.	- -	56,650
Miscellaneous Management Facilities	Dollars	- -	83,000
Purchase or Exchange of Land	Acres	94,750	2,146,500
Grounds Development & Small Structures	No.	14	56,300

TABLE IV-B-2 Quantities and Annual Costs -- Recurring Measures

For Public & Private Lands In Big Bend-Palouse-Lower Snake

Measures	Total Annual Needed Program Quantity (Acres)	Cost (Dollars)
CROPLAND MEASURES		
Contour farming	1,668,900	417,200
Crop residue utilization	1,959,500	5,972,500
Subsoiling	81,471	675,800
Other tilling	831,050	831,050
Green manuring & cover cropping	281,400	2,814,000
Rotation seedings	235,665	2,828,000
Pasture seeding	40,000	600,100
Pasture management	621,250	1,863,800
Liming	1,200	18,000
Fertilizing		
To establish soil conserving crops	6,735	80,840
To increase production	1,243,000	22,373,900
Improving water application	1,059,000	0
Correcting soil salinity	3,200	48,000
RANGE RESOURCE MEASURES		
Proper stocking	1,953,000	97,650
Deferred grazing	838,300	83,800
Fire protection	2,862,000	85,860
FOREST RESOURCES MEASURES		
Fire protection, organization and equipment	- -	62,000
ADMINISTRATIVE & MANAGEMENT MEASURES		
Intensified management	- -	74,900
Technical assistance on forest land	- -	7,900

TABLE IV-B-2a Recurring Annual Operation, Maintenance & Replacement Costs

For Public & Private Lands In Big Bend-Palouse-Lower Snake

Kind of Measures	Total Annual Needed Program (Dollars)
Cropland Measures	6,411,550
Range Resource Measures	691,200
Forest Land Resource Measures	99,200
Measures Not Associated with One Land Use	355,950
Administrative & Management Measures	86,300

TABLE IV-B-1 Quantities and Installation Costs - Non-Recurring Measures

For All Private In Big Bend-Palouse-Lower Snake

Measures	Unit	Total Needed Program Quantity (Units)	Total Needed Program Cost (Dollars)
CROPLAND MEASURES			
Soil Protection and Improvement			
Contour stripping and planting	Acres	1,098,400	1,153,300
Terracing	Miles	450	45,000
Field diversions	Miles	1,180	236,200
Field strip cropping	Acres	745,000	223,500
Drainage Improvement			
Individual farm drains	Acres	82,000	633,600
Community systems	Miles	30	125,000
Irrigated Land Treatment			
Preparing land for irrigation	Acres	964,000	53,020,000
Improving farm irrigation systems	Acres	30,000	600,000
Improving trunk line systems	Acres	8,000	80,000
Developing irrigation facilities	No.	1,400	1,400,000
New farm irrigation systems	No.	14,000	70,000,000
Miscellaneous			
Farm ponds	No.	1,335	1,335,000
Wildlife areas	Acres	26,150	2,092,000
Liquid manure tanks	No.	60	120,000
Cleanup clearing	Acres	20,500	205,000
Weed control	Acres	175,000	1,225,000
Fire protection	Acres	3,673,000	202,000
Rodent control	Acres	236,600	354,900
Insect control	Acres	78,400	548,800
Windbreak & shelter belt planting	Acres	10,500	367,500
Clearing forest land	Acres	500	20,000
RANGE RESOURCE MEASURES			
Cover Improvement and Protection			
Seeding and planting	Acres	617,000	4,793,700
Protective fencing	Miles	310	108,850
Sagebrush & other woody plant control	Acres	377,600	1,132,400
Water spreading & irrigation	Acres	4,000	40,000
Fertilizing	Acres	424,500	2,122,500
Management Improvement			
Exclusion	Acres	606,000	0
Improvement of Livestock Distribution and Management			
Water storage facilities	No.	1,600	788,250
Springs and seeps	No.	1,060	318,500
Stockwater wells	No.	600	9,000
Fencing	Miles	1,350	890,000
Driveways and driftways	Miles	110	44,000
Misc. stock handling facilities	No.	0	0
Miscellaneous			
Rodent control	Acres	49,800	24,900
Insect control	Acres	50,900	45,450
Weed control	Acres	177,100	1,062,900

TABLE IV-B-1 All Private

Measures	Unit	Total Needed Program Quantity (Units)	Total Needed Program Cost (Dollars)
FOREST RESOURCES MEASURES			
Management Improvement			
Planting forest trees	Acres	26,000	913,000
Improvement of stands	Acres	34,700	693,200
Forest Protection (except fire)			
Insect control	Acres	8,800	85,600
Forest disease control	Acres	600	2,500
Rodent control	Acres	13,400	6,900
Fire Control Improvements(protection)	Dollars	- -	45,400
MEASURES NOT ASSOCIATED WITH ONE LAND USE			
Fish & Wildlife Resource Measures			
Cover and food plantings	Acres	- -	- -
Water developments	No.	- -	- -
Fencing	Miles	- -	- -
Habitat improvement-streams	Miles	- -	- -
Habitat improvement-lakes	Acres	- -	- -
Hatcheries and pond projects	No.	- -	- -
Other			
Stabilizing dunes and blowouts	Acres	35	7,000
Stream pollution control	No.	- -	- -
Stabilizing waterways and outlets	Miles	19,300	2,310,150
Erosion and drainage control on roads and trails	Miles	115	42,500
Stabilizing slips and slides	Acres	4	17,000
Severe sheet erosion control(public)	Acres	720	33,900
ADMINISTRATIVE & MANAGEMENT MEASURES			
Technical Services(private crop,range)	Dollars	- -	- -
Resource Development Plans	Acres	1,512,000	14,890
Transportation Facilities			
Roads	Miles	- -	- -
Trails	Miles	13	9,000
Airplane fields	No.	- -	- -
Helicopter spots	No.	5	1,200
Communication Facilities			
Telephone lines	Miles	6	8,740
Radio installation	No.	4	4,000
Buildings			
Dwellings, dormitories and misc.	No.	1	12,000
Offices	No.	- -	- -
Warehouses, garages and utility	No.	4	16,550
Water and Sanitary Systems			
Water systems	No.	2	6,100
Sanitary systems	No.	2	4,000
Recreation Facilities			
Camp & picnic areas - family units	No.	- -	- -
Shelters and bath houses	No.	- -	- -
Winter sports areas	No.	- -	- -
Misc. recreation facilities	No.	- -	- -
Clean-up and disposal projects	No.	- -	- -
Miscellaneous Management Facilities	Dollars	- -	3,400
Purchase or Exchange of Land	Acres		
Grounds Development & Small Structures	No.	2	4,900

TABLE IV-B-2 Quantities and Annual Costs -- Recurring Measures

For All Private In Big Bend-Palouse-Lower Snake

Measures	Total Annual Quantity	Needed Program Cost
	(Acres)	(Dollars)
CROPLAND MEASURES		
Contour farming	1,638,000	409,500
Crop residue utilization	1,926,500	5,873,500
subsoiling	79,200	657,600
Other tilling	806,500	806,500
Green manuring & cover cropping	275,500	2,755,000
Rotation seedings	228,125	2,737,500
Pasture seeding	39,410	591,240
Pasture management	614,000	1,842,000
Liming	1,200	18,000
Fertilizing		
To establish soil conserving crops	6,735	80,840
To increase production	1,242,990	22,373,820
Improving water application	1,059,000	0
Correcting soil salinity	3,200	48,000
RANGE RESOURCE MEASURES		
Proper stocking	1,953,000	97,650
Deferred grazing	838,300	83,800
Fire protection	2,862,000	85,860
FOREST RESOURCES MEASURES		
Fire protection, organization and equipment	- -	40,300
ADMINISTRATIVE & MANAGEMENT MEASURES		
Intensified management	- -	- -
Technical assistance on forest land	- -	7,900

TABLE IV-B-2a Recurring Annual Operation, Maintenance & Replacement Costs

For All Private In Big Bend-Palouse-Lower Snake

Kind of Measures	Total Annual Needed Program
	(Dollars)
Cropland Measures	6,392,600
Range Resource Measures	664,300
Forest Land Resource Measures	54,100
Measures Not Associated with One Land Use	355,950
Administrative & Management Measures	5,200

TABLE IV-B-1 Quantities and Installation Costs - Non-Recurring Measures

For Public (USDA) In Big Bend-Palouse-Lower Snake

Measures	Unit	Total Needed Program Quantity (Units)	Cost (Dollars)
CROPLAND MEASURES			
Soil Protection and Improvement			
Contour stripping and planting	Acres	- -	- -
Terracing	Miles	- -	- -
Field diversions	Miles	- -	- -
Field strip cropping	Acres	- -	- -
Drainage Improvement			
Individual farm drains	Acres	- -	- -
Community systems	Miles	- -	- -
Irrigated Land Treatment			
Preparing land for irrigation	Acres	- -	- -
Improving farm irrigation systems	Acres	- -	- -
Improving trunk line systems	Acres	- -	- -
Developing irrigation facilities	No.	- -	- -
New farm irrigation systems	No.	- -	- -
Miscellaneous			
Farm ponds	No.	- -	- -
Wildlife areas	Acres	- -	- -
Liquid manure tanks	No.	- -	- -
Cleanup clearing	Acres	- -	- -
Weed control	Acres	- -	- -
Fire protection	Acres	- -	- -
Rodent control	Acres	- -	- -
Insect control	Acres	- -	- -
Windbreak & shelter belt planting	Acres	- -	- -
Clearing forest land	Acres	- -	- -
RANGE RESOURCE MEASURES			
Cover Improvement and Protection			
Seeding and planting	Acres	4,000	43,100
Protective fencing	Miles	- -	- -
Sagebrush & other woody plant control	Acres	- -	- -
Water spreading & irrigation	Acres	- -	- -
Fertilizing	Acres	1,500	30,000
Management Improvement			
Exclusion	Acres	- -	- -
Improvement of Livestock Distribution and Management			
Water storage facilities	No.	39	17,500
Springs and seeps	No.	- -	- -
Stockwater wells	No.	- -	- -
Fencing	Miles	52	58,600
Driveways and driftways	Miles	19	5,640
Misc. stock handling facilities	No.	19	13,900
Miscellaneous			
Rodent control	Acres	3,360	1,680
Insect control	Acres	8,770	7,900
Weed control	Acres	1,200	10,050

TABLE IV-B-1 Public (USDA) Big Bend-Palouse-Lower Snake

Measures	Unit	Total Needed Program Quantity	Cost
FOREST RESOURCES MEASURES		(Units)	(Dollars)
Management Improvement			
Planting forest trees	Acres	4,060	142,000
Improvement of stands	Acres	11,500	233,300
Forest Protection (except fire)			
Insect control	Acres	9,370	93,700
Forest disease control	Acres	12,060	513,700
Rodent control	Acres	25,040	12,620
Fire Control Improvements (protection)	Dollars	- -	198,750
MEASURES NOT ASSOCIATED WITH ONE LAND USE			
Fish & Wildlife Resource Measures			
Cover and food plantings	Acres	5,940	86,660
Water developments	No.	- -	- -
Fencing	Miles	- -	- -
Habitat improvement-streams	Miles	14	8,370
Habitat improvement-lakes	Acres	60	1,530
Hatcheries and pond projects	No.	- -	- -
Other			
Stabilizing dunes and blowouts	Acres	- -	- -
Stream pollution control	No.	- -	- -
Stabilizing waterways and outlets	Miles	2	4,300
Erosion and drainage control on roads and trails	Miles	190	74,600
Stabilizing slips and slides	Acres	11	51,400
Severe sheet erosion control (public)	Acres	1,400	71,000
ADMINISTRATIVE & MANAGEMENT MEASURES			
Technical Services (private crop, range)	Dollars	- -	- -
Resource Development Plans	Acres	6,049,000	91,890
Transportation Facilities			
Roads	Miles	248	4,276,600
Trails	Miles	290	280,400
Airplane fields	No.	1	40,000
Helicopter spots	No.	26	6,400
Communication Facilities			
Telephone lines	Miles	29	30,800
Radio installation	No.	16	14,800
Buildings			
Dwellings, dormitories and misc.	No.	17	193,680
Offices	No.	4	26,800
Warehouses, garages and utility	No.	30	111,200
Water and Sanitary Systems			
Water systems	No.	14	55,000
Sanitary systems	No.	14	40,000
Recreation Facilities			
Camp & Picnic areas - family units	No.	310	226,500
Shelters and bath houses	No.	1	10,000
Winter sports areas	No.	- -	- -
Misc. recreation facilities	No.	4	4,000
Clean-up and disposal projects	No.	- -	24,650
Miscellaneous Management Facilities	Dollars	- -	35,000
Purchase or Exchange of Land	Acres	16,000	98,300
Grounds Development & Small Structures	No.	8	31,400

TABLE IV-B-2 Quantities and Annual Costs -- Recurring Measures

For Public (USDA) In Big Bend-Palouse-Lower Snake

Measures	Total Annual Needed Program Quantity (Acres)	Cost (Dollars)
CROPLAND MEASURES		
Contour farming	- -	- -
Crop residue utilization	- -	- -
Subsoiling	- -	- -
Other tilling	- -	- -
Green manuring & cover cropping	- -	- -
Rotation seedings	- -	- -
Pasture seeding	- -	- -
Pasture management	- -	- -
Liming	- -	- -
Fertilizing		
To establish soil conserving crops	- -	- -
To increase production	- -	- -
Improving water application	- -	- -
Correcting soil salinity	- -	- -
RANGE RESOURCE MEASURES		
Proper stocking	- -	- -
Deferred grazing	- -	- -
Fire protection	- -	- -
FOREST RESOURCES MEASURES		
Fire protection, organization and equipment	- -	16,300
ADMINISTRATIVE & MANAGEMENT MEASURES		
Intensified management		58,300
Technical assistance on forest land		

TABLE IV-B-2a Recurring Annual Operation, Maintenance & Replacement Costs

For Public (USDA) In Big Bend-Palouse-Lower Snake

Kind of Measures	Total Annual Needed Program (Dollars)
Cropland Measures	- -
Range Resource Measures	4,700
Forest Land Resource Measures	38,600
Measures Not Associated with One Land Use	- -
Administrative & Management Measures	77,800

TABLE IV-B-1 Quantities and Installation Costs - Non-Recurring Measures

For Public (State) In Big Bend-Palouse-Lower Snake

Measures	Unit	Total Needed Program Quantity (Units)	Cost (Dollars)
CROPLAND MEASURES			
Soil Protection and Improvement			
Contour stripping and planting	Acres	24,140	25,347
Terracing	Miles	4	400
Field diversions	Miles	6	1,200
Field s trip cropping	Acres	16,550	4,965
Drainage Improvement			
Individual farm drains	Acres	4,425	14,000
Community systems	Miles	0	0
Irrigated Land Treatment			
Preparing land for irrigation	Acres	0	0
Improving farm irrigation systems	Acres	0	0
Improving trunk line systems	Acres	0	0
Developing irrigation facilities	No.	0	0
New farm irrigation systems	No.	0	0
Miscellaneous			
Farm ponds	No.	12	12,000
Wildlife areas	Acres	255	200
Liquid manure tanks	No.	0	0
Cleanup clearing	Acres	0	0
Weed control	Acres	4,000	28,000
Fire protection	Acres	0	0
Rodent control	Acres	4,285	6,425
Insect control	Acres	1,200	8,400
Windbreak & shelter belt planting	Acres	0	0
Clearing forest land	Acres	0	0
RANGE RESOURCE MEASURES			
Cover Improvement and Protection			
Seeding and planting	Acres	1,130	13,525
Protective fencing	Miles	0	0
Sagebrush & other woody plant control	Acres	0	0
Water spreading & irrigation	Acres	0	0
Fertilizing	Acres	0	0
Management Improvement			
Exclusion	Acres	0	0
Improvement of Livestock Distribution and Management			
Water storage facilities	No.	- -	- -
Springs and seeps	No.	- -	- -
Stockwater wells	No.	- -	- -
Fencing	Miles	- -	- -
Driveways and driftways	Miles	- -	- -
Misc. stock handling facilities	No.	- -	- -
Miscellaneous			
Rodent control	Acres	- -	- -
Insect control	Acres	- -	- -
Weed control	Acres	- -	- -

TABLE IV-B-1 Public (State) Big Bend-Palouse-Lower Snake

Measures	Unit	Total Needed Program Quantity (Units)	Total Needed Program Cost (Dollars)
FOREST RESOURCES MEASURES			
Management Improvement			
Planting forest trees	Acres	- -	- -
Improvement of stands	Acres	- -	- -
Forest Protection (except fire)			
Insect control	Acres	- -	- -
Forest disease control	Acres	- -	- -
Rodent control	Acres	- -	- -
Fire Control Improvements (protection)	Dollars	- -	- -
MEASURES NOT ASSOCIATED WITH ONE LAND USE			
Fish & Wildlife Resource Measures			
Cover and food plantings	Acres	- -	- -
Water developments	No.	- -	- -
Fencing	Miles	- -	- -
Habitat improvement-streams	Miles	- -	- -
Habitat improvement-lakes	Acres	- -	- -
Hatcheries and pond projects	No.	- -	- -
Other			
Stabilizing dunes and blowouts	Acres	- -	- -
Stream pollution control	No.	- -	- -
Stabilizing waterways and outlets	Miles	- -	- -
Erosion and drainage control on roads and trails	Miles	- -	- -
Stabilizing slips and slides	Acres	- -	- -
Severe sheet erosion control (public)	Acres	- -	- -
ADMINISTRATIVE & MANAGEMENT MEASURES			
Technical Services (private crop, range)	Dollars	- -	- -
Resource Development Plans	Acres	- -	- -
Transportation Facilities			
Roads	Miles	- -	- -
Trails	Miles	- -	- -
Airplane fields	No.	- -	- -
Helicopter spots	No.	- -	- -
Communication Facilities			
Telephone lines	Miles	- -	- -
Radio installation	No.	- -	- -
Buildings			
Dwellings, dormitories and misc.	No.	- -	- -
Offices	No.	- -	- -
Warehouses, garages and utility	No.	- -	- -
Water and Sanitary Systems			
Water systems	No.	- -	- -
Sanitary systems	No.	- -	- -
Recreation Facilities			
Camp & picnic areas - family units	No.	- -	- -
Shelters and bath houses	No.	- -	- -
Winter sports areas	No.	- -	- -
Misc. recreation facilities	No.	- -	- -
Clean-up and disposal projects	No.	- -	- -
Miscellaneous Management Facilities	Dollars	- -	- -
Purchase or Exchange of Land	Acres	- -	- -
Grounds Development & Small Structures	No.	- -	- -

TABLE IV-B-2 Quantities and Annual Costs -- Recurring Measures

For Public (State) In Big Bend-Palouse-Lower Snake

Measures	Total Annual Needed Program Quantity (Acres)	Cost (Dollars)
CROPLAND MEASURES		
Contour farming	30,920	7,730
Crop residue utilization	33,000	99,000
Subsoiling	2,270	18,170
Other tilling	24,550	24,550
Green manuring & cover cropping	5,900	59,000
Rotation seedings	7,540	90,480
Pasture seeding	590	8,850
Pasture management	7,250	21,810
Liming	0	0
Fertilizing		
To establish soil conserving crops	0	0
To increase production	0	0
Improving water application	0	0
Correcting soil salinity	0	0
RANGE RESOURCE MEASURES		
Proper stocking	0	0
Deferred grazing	0	0
Fire protection	0	0
FOREST RESOURCES MEASURES		
Fire protection, organization and equipment	- -	- -
ADMINISTRATIVE & MANAGEMENT MEASURES		
Intensified management	- -	- -
Technical assistance on forest land	- -	- -

TABLE IV-B-2a Recurring Annual Operation, Maintenance & Replacement Costs

For Public (State) In Big Bend-Palouse-Lower Snake

Kind of Measures	Total Annual Needed Program (Dollars)
Cropland Measures	18,923
Range Resource Measures	0
Forest Land Resource Measures	- -
Measures Not Associated with One Land Use	0
Administrative & Management Measures	- -

TABLE IV-B-1 Quantities and Installation Costs - Non-Recurring Measures

For Public & Private Lands In Big Bend-Palouse-Lower Snake (Idaho)

Measures	Unit	Total Needed Program Quantity	Cost
CROPLAND MEASURES		(Units)	(Dollars)
Soil Protection and Improvement			
Contour stripping and planting	Acres	120,240	126,250
Terracing	Miles	0	0
Field diversions	Miles	180	36,400
Field strip cropping	Acres	- -	- -
Drainage Improvement			
Individual farm drains	Acres	2,000	58,600
Community systems	Miles	15	75,000
Irrigated Land Treatment			
Preparing land for irrigation	Acres	- -	- -
Improving farm irrigation systems	Acres	- -	- -
Improving trunk line systems	Acres	- -	- -
Developing irrigation facilities	No.	- -	- -
New farm irrigation systems	No.	- -	- -
Miscellaneous			
Farm ponds	No.	135	135,000
Wildlife areas	Acres	150	12,000
Liquid manure tanks	No.	0	0
Cleanup clearing	Acres	500	5,000
Weed control	Acres	3,000	21,000
Fire protection	Acres	0	0
Rodent control	Acres	26,700	40,050
Insect control	Acres	10,000	70,000
Windbreak & shelter belt planting	Acres	500	17,500
Clearing forest land	Acres	150	6,000
RANGE RESOURCE MEASURES			
Cover Improvement and Protection			
Seeding and planting	Acres	6,100	62,200
Protective fencing	Miles	0	0
Sagebrush & other woody plant control	Acres	1,000	3,000
Water spreading & Irrigation	Acres	- -	- -
Fertilizing	Acres	2,500	12,500
Management Improvement			
Exclusion	Acres	2,500	0
Improvement of Livestock Distribution and Management			
Water storage facilities	No.	16	7,800
Springs and seeps	No.	25	7,500
Stockwater wells	No.	0	0
Fencing	Miles	56	23,900
Driveways and driftways	Miles	0	0
Misc. stock handling facilities	No.	- -	- -
Miscellaneous			
Rodent control	Acres	0	0
Insect control	Acres	600	550
Weed control	Acres	4,600	27,500

TABLE IV-B-1 Public & Private Lands - Big Bend-Palouse-Lower Snake (Idaho)

Measures	Unit	Total Needed Program Quantity	Cost
FOREST RESOURCES MEASURES		(Units)	(Dollars)
Management Improvement			
Planting forest trees	Acres	5,800	206,000
Improvement of stands	Acres	7,600	154,500
Forest Protection (except fire)			
Insect control	Acres	5,000	47,800
Forest disease control	Acres	11,700	498,400
Rodent control	Acres	9,000	4,800
Fire Control Improvements (protection)	Dollars	- -	42,700
MEASURES NOT ASSOCIATED WITH ONE LAND USE			
Fish & Wildlife Resource Measures			
Cover and food plantings	Acres	900	11,000
Water developments	No.	- -	- -
Fencing	Miles	- -	- -
Habitat improvement-streams	Miles	5	3,000
Habitat improvement-lakes	Acres	- -	- -
Hatcheries and pond projects	No.	- -	- -
Other			
Stabilizing dunes and blowouts	Acres	- -	- -
Stream pollution control	No.	- -	- -
Stabilizing waterways and outlets	Miles	325	135,100
Erosion and drainage control on roads and trails	Miles	47	16,700
Stabilizing slips and slides	Acres	- -	- -
Severe sheet erosion control (public)	Acres	120	3,900
ADMINISTRATIVE & MANAGEMENT MEASURES			
Technical Services(private crop, range)	Dollars	- -	- -
Resource Development Plans	Acres	1,417,000	17,500
Transportation Facilities			
Roads	Miles	30	540,600
Trails	Miles	37	32,900
Airplane fields	No.	- -	- -
Helicopter spots	No.	9	2,200
Communication Facilities			
Telephone lines	Miles	5	6,800
Radio installation	No.	2	2,300
Buildings			
Dwellings, dormitories and misc.	No.	2	30,000
Offices	No.	1	6,800
Warehouses, garages and utility	No.	5	17,800
Water and Sanitary Systems			
Water systems	No.	3	9,100
Sanitary systems	No.	3	6,000
Recreation Facilities			
Camp & picnic areas - family units	No.	9	13,400
Shelters and bath houses	No.	1	10,000
Winter sports areas	No.	- -	- -
Misc. recreation facilities	No.	1	1,000
Clean-up and disposal projects	No.	- -	400
Miscellaneous Management Facilities	Dollars	- -	6,600
Purchase or Exchange of Land	Acres	2,000	10,000
Grounds Development & Small Structures	No.	2	4,300

TABLE IV-B-2 Quantities and Annual Costs - Recurring Measures

For Public & Private Lands In Big Bend-Palouse-Lower Snake (Idaho)

Measures	Total Annual Needed Program Quantity	Cost
	(Acres)	(Dollars)
CROPLAND MEASURES		
Contour farming	30,000	7,500
Crop residue utilization	12,530	37,595
Subsoiling	2,030	46,240
Other tilling	15,000	15,000
Green manuring & cover cropping	6,280	62,820
Rotation seedings	5,023	60,275
Pasture seeding	1,085	16,300
Pasture management	14,045	42,200
Liming	0	0
Fertilizing		
To establish soil conserving crops	0	0
To increase production	0	0
Improving water application	0	0
Correcting soil salinity	0	0
RANGE RESOURCE MEASURES		
Proper stocking	30,000	1,500
Deferred grazing	5,000	500
Fire protection	0	0
FOREST RESOURCES MEASURES		
Fire protection, organization and equipment	- -	18,900
ADMINISTRATIVE & MANAGEMENT MEASURES		
Intensified management	- -	6,500
Technical assistance on forest land	- -	2,700

TABLE IV-B-2a Recurring Annual Operation, Maintenance & Replacement Costs

For Public & Private Lands In Big Bend-Palouse-Lower Snake (Idaho)

Kind of Measures	Total Annual Needed Program
	(Dollars)
Cropland Measures	54,300
Range Resource Measures	5,800
Forest Land Resource Measures	18,800
Measures Not Associated with One Land Use	6,950
Administrative & Management Measures	10,700

TABLE IV-B-1 Quantities and Installation Costs - Non-Recurring Measures

For Private In Big Bend-Palouse-Lower Snake (Idaho)

Measures	Unit	Total Needed Program Quantity (Units)	Total Needed Program Cost (Dollars)
CROPLAND MEASURES			
Soil Protection and Improvement			
Contour stripping and planting	Acres	120,000	126,000
Terracing	Miles	0	0
Field diversions	Miles	180	36,200
Field strip cropping	Acres	0	0
Drainage Improvement			
Individual farm drains	Acres	2,000	58,600
Community systems	Miles	15	75,000
Irrigated Land Treatment			
Preparing land for irrigation	Acres	0	0
Improving farm irrigation systems	Acres	0	0
Improving trunk line systems	Acres	0	0
Developing irrigation facilities	No.	0	0
New farm irrigation systems	No.	0	0
Miscellaneous			
Farm ponds	No.	135	135,000
Wildlife areas	Acres	150	12,000
Liquid manure tanks	No.	0	0
Cleanup clearing	Acres	500	5,000
Weed control	Acres	3,000	21,000
Fire protection	Acres	0	0
Rodent control	Acres	26,700	40,050
Insect control	Acres	10,000	70,000
Windbreak & shelter belt planting	Acres	500	17,500
Clearing forest land	Acres	150	6,000
RANGE RESOURCE MEASURES			
Cover Improvement and Protection			
Seeding and planting	Acres	6,000	61,100
Protective fencing	Miles	0	0
Sagebrush & other woody plant control	Acres	1,000	3,000
Water spreading & irrigation	Acres	0	0
Fertilizing	Acres	2,500	12,500
Management Improvement			
Exclusion	Acres	2,500	0
Improvement of Livestock Distribution and Management			
Water storage facilities	No.	15	7,300
Springs and seeps	No.	25	7,500
Stockwater wells	No.	0	0
Fencing	Miles	55	23,000
Driveways and driftways	Miles	0	0
Misc. stock handling facilities	No.	0	0
Miscellaneous			
Rodent control	Acres	0	0
Insect control	Acres	500	450
Weed control	Acres	4,300	24,500

TABLE IV-B-1 Private (Idaho)

Measures	Unit	Total Needed Program Quantity (Units)	Total Needed Program Cost (Dollars)
FOREST RESOURCES MEASURES			
Management Improvement			
Planting forest trees	Acres	4,000	143,000
Improvement of stands	Acres	5,800	115,200
Forest Protection (except fire)			
Insect control	Acres	4,000	37,800
Forest disease control	Acres	- -	- -
Rodent control	Acres	4,000	2,200
Fire Control Improvements (protection)	Dollars	- -	23,800
MEASURES NOT ASSOCIATED WITH ONE LAND USE			
Fish & Wildlife Resource Measures			
Cover and food plantings	Acres	- -	- -
Water developments	No.	- -	- -
Fencing	Miles	- -	- -
Habitat improvement-streams	Miles	- -	- -
Habitat improvement-lakes	Acres	- -	- -
Hatcheries and pond projects	No.	- -	- -
Other			
Stabilizing dunes and blowouts	Acres	- -	- -
Stream pollution control	No.	- -	- -
Stabilizing waterways and outlets	Miles	323	130,800
Erosion and drainage control on roads and trails	Miles	- -	- -
Stabilizing slips and slides	Acres	- -	- -
Severe sheet erosion control (public)	Acres	- -	- -
ADMINISTRATIVE & MANAGEMENT MEASURES			
Technical Services (private crop, range)	Dollars	- -	- -
Resource Development Plans	Acres	774,000	6,700
Transportation Facilities			
Roads	Miles	- -	- -
Trails	Miles	13	9,000
Airplane fields	No.	- -	- -
Helicopter spots	No.	5	1,200
Communication Facilities			
Telephone lines	Miles	2	4,300
Radio installation	No.	1	1,300
Buildings			
Dwellings, dormitories and misc.	No.	- -	- -
Offices	No.	- -	- -
Warehouses, garages and utility	No.	- -	- -
Water and Sanitary Systems			
Water systems	No.	1	2,100
Sanitary systems	No.	1	1,000
Recreation Facilities			
Camp & Picnic areas - family units	No.	- -	- -
Shelters and bath houses	No.	- -	- -
Winter sports areas	No.	- -	- -
Misc. recreation facilities	No.	- -	- -
Clean-up and disposal projects	No.	- -	- -
Miscellaneous Management Facilities	Dollars	- -	3,400
Purchase or Exchange of Land	Acres	- -	- -
Grounds Development & Small Structures	No.	1	900

TABLE IV-B-2 Quantities and Annual Costs -- Recurring Measures

For Private In Big Bend-Palouse-Lower Snake (Idaho)

Measures	Total Annual Needed Program Quantity (Acres)	Cost (Dollars)
CROPLAND MEASURES		
Contour farming	30,000	7,500
Crop residue utilization	12,500	37,500
Subsoiling	2,000	40,000
Other tilling	15,000	15,000
Green manuring & cover cropping	6,250	62,500
Rotation seedings	5,000	60,000
Pasture seeding	1,083	16,245
Pasture management	14,000	42,000
Liming	0	0
Fertilizing		
To establish soil conserving crops	0	0
To increase production	0	0
Improving water application	0	0
Correcting soil salinity	0	0
RANGE RESOURCE MEASURES		
Proper stocking	30,000	1,500
Deferred grazing	5,000	500
Fire protection	0	0
FOREST RESOURCES MEASURES		
Fire protection, organization and equipment	- -	15,900
ADMINISTRATIVE & MANAGEMENT MEASURES		
Intensified management	- -	- -
Technical assistance on forest land	- -	2,700

TABLE IV-B-2a Recurring Annual Operation, Maintenance & Replacement Costs

For Private In Big Bend-Palouse-Lower Snake (Idaho)

Kind of Measures	Total Annual Needed Program (Dollars)
Cropland Measures	54,300
Range Resource Measures	5,800
Forest Land Resource Measures	13,900
Measures Not Associated with One Land Use	6,950
Administrative & Management Measures	- -

TABLE IV-B-1 Quantities and Installation Costs -- Non-Recurring Measures

For Public (USDA) In Big Bend-Palouse-Lower Snake (Idaho)

Measures	Unit	Total Needed Program Quantity (Units)	Total Needed Program Cost (Dollars)
CROPLAND MEASURES			
Soil Protection and Improvement			
Contour stripping and planting	Acres	- -	- -
Terracing	Miles	- -	- -
Field diversions	Miles	- -	- -
Field strip cropping	Acres	- -	- -
Drainage Improvement			
Individual farm drains	Acres	- -	- -
Community systems	Miles	- -	- -
Irrigated Land Treatment			
Preparing land for irrigation	Acres	- -	- -
Improving farm irrigation systems	Acres	- -	- -
Improving trunk line systems	Acres	- -	- -
Developing irrigation facilities	No.	- -	- -
New farm irrigation systems	No.	- -	- -
Miscellaneous			
Farm ponds	No.	- -	- -
Wildlife areas	Acres	- -	- -
Liquid manure tanks	No.	- -	- -
Cleanup clearing	Acres	- -	- -
Weed control	Acres	- -	- -
Fire protection	Acres	- -	- -
Rodent control	Acres	- -	- -
Insect control	Acres	- -	- -
Windbreak & shelter belt planting	Acres	- -	- -
Clearing forest land	Acres	- -	- -
RANGE RESOURCE MEASURES			
Cover Improvement and Protection			
Seeding and planting	Acres	100	1,100
Protective fencing	Miles	- -	- -
Sagebrush & other woody plant control	Acres	- -	- -
Water spreading & irrigation	Acres	- -	- -
Fertilizing	Acres	- -	- -
Management Improvement			
Exclusion	Acres	- -	- -
Improvement of Livestock Distribution and Management			
Water storage facilities	No.)		
Springs and seeps	No.)	1	500
Stockwater wells	No.	- -	- -
Fencing	Miles	1	900
Driveways and driftways	Miles	- -	- -
Misc. stock handling facilities	No.	- -	- -
Miscellaneous			
Rodent control	Acres	- -	- -
Insect control	Acres	100	100
Weed control	Acres	300	3,000

TABLE IV-B-1 Public (USDA) (Idaho)

Measures	Unit	Total Needed Program Quantity (Units)	Total Needed Program Cost (Dollars)
FOREST RESOURCES MEASURES			
Management Improvement			
Planting forest trees	Acres	1,800	63,000
Improvement of stands	Acres	1,800	39,300
Forest Protection (except fire)			
Insect control	Acres	1,000	10,000
Forest disease control	Acres	11,700	498,400
Rodent control	Acres	5,000	2,600
Fire Control Improvements (protection)	Dollars	- -	18,900
MEASURES NOT ASSOCIATED WITH ONE LAND USE			
Fish & Wildlife Resource Measures			
Cover and food plantings	Acres	900	11,000
Water developments	No.	- -	- -
Fencing	Miles	- -	- -
Habitat improvement-streams	Miles	5	3,000
Habitat improvement-lakes	Acres	- -	- -
Hatcheries and pond projects	No.	- -	- -
Other			
Stabilizing dunes and blowouts	Acres	- -	- -
Stream pollution control	No.	- -	- -
Stabilizing waterways and outlets	Miles	2	4,300
Erosion and drainage control on roads and trails	Miles	13	4,600
Stabilizing slips and slides	Acres	- -	- -
Severe sheet erosion control (public)	Acres	- -	- -
ADMINISTRATIVE & MANAGEMENT MEASURES			
Technical Services (private crop, range)	Dollars	- -	- -
Resource Development Plans	Acres	643,000	10,800
Transportation Facilities			
Roads	Miles	30	540,600
Trails	Miles	24	23,900
Airplane fields	No.	0	0
Helicopter spots	No.	4	1,000
Communication Facilities			
Telephone lines	Miles	3	2,500
Radio installation	No.	1	1,000
Buildings			
Dwellings, dormitories and misc.	No.	2	30,000
Offices	No.	1	6,800
Warehouses, garages and utility	No.	5	17,800
Water and Sanitary Systems			
Water systems	No.	2	7,000
Sanitary systems	No.	2	5,000
Recreation Facilities			
Camp & picnic areas - family units	No.	9	13,400
Shelters and bath houses	No.	1	10,000
Winter sports areas	No.	- -	- -
Misc. recreation facilities	No.	1	1,000
Clean-up and disposal projects	No.	- -	400
Miscellaneous Management Facilities	Dollars	- -	3,200
Purchase or Exchange of Land	Acres	2,000	10,000
Grounds Development & Small Structures	No.	1	3,400

TABLE IV-B-2 Quantities and Annual Costs -- Recurring Measures

For Public (USDA) In Big Bend-Palouse-Lower Snake (Idaho)

Measures	Total Annual Needed Program Quantity (Acres)	Cost (Dollars)
CROPLAND MEASURES		
Contour farming	- -	- -
Crop residue utilization	- -	- -
Subsoiling	- -	- -
Other tilling	- -	- -
Green manuring & cover cropping	- -	- -
Rotation seedings	- -	- -
Pasture seeding	- -	- -
Pasture management	- -	- -
Liming	- -	- -
Fertilizing		
To establish soil conserving crops	- -	- -
To increase production	- -	- -
Improving water application	- -	- -
Correcting soil salinity	- -	- -
RANGE RESOURCE MEASURES		
Proper stocking	- -	- -
Deferred grazing	- -	- -
Fire protection	- -	- -
FOREST RESOURCES MEASURES		
Fire protection, organization and equipment	- -	3,000
ADMINISTRATIVE & MANAGEMENT MEASURES		
Intensified management	- -	6,500
Technical assistance on forest land	- -	- -

TABLE IV-B-2a Recurring Annual Operation, Maintenance & Replacement Costs

For Public (USDA) In Big Bend-Palouse-Lower Snake (Idaho)

Kind of Measures	Total Annual Needed Program (Dollars)
Cropland Measures	- -
Range Resource Measures	- -
Forest Land Resource Measures	4,900
Measures Not Associated with One Land Use	- -
Administrative & Management Measures	10,700

TABLE IV-B-1 Quantities and Installation Costs - Non-Recurring Measures

For Public (State) In Big Bend-Palouse-Lower Snake (Idaho)

Measures	Unit	Total Needed Program Quantity (Units)	Cost (Dollars)
CROPLAND MEASURES			
Soil Protection and Improvement			
Contour stripping and planting	Acres	242	254
Terracing	Miles	0	0
Field diversions	Miles	1	200
Field strip cropping	Acres	0	0
Drainage Improvement			
Individual farm drains	Acres	- -	- -
Community systems	Miles	- -	- -
Irrigated Land Treatment			
Preparing land for irrigation	Acres	- -	- -
Improving farm irrigation systems	Acres	- -	- -
Improving trunk line systems	Acres	- -	- -
Developing irrigation facilities	No.	- -	- -
New farm irrigation systems	No.	- -	- -
Miscellaneous			
Farm ponds	No.	- -	- -
Wildlife areas	Acres	- -	- -
Liquid manure tanks	No.	- -	- -
Cleanup clearing	Acres	- -	- -
Weed control	Acres	0	0
Fire protection	Acres	0	0
Rodent control	Acres	0	0
Insect control	Acres	0	0
Windbreak & shelter belt planting	Acres	- -	- -
Clearing forest land	Acres	- -	- -
RANGE RESOURCE MEASURES			
Cover Improvement and Protection			
Seeding and planting	Acres	- -	- -
Protective fencing	Miles	- -	- -
Sagebrush & other woody plant control	Acres	- -	- -
Water spreading & irrigation	Acres	- -	- -
Fertilizing	Acres	- -	- -
Management Improvement			
Exclusion	Acres	- -	- -
Improvement of Livestock Distribution and Management			
Water storage facilities	No.	- -	- -
Springs and seeps	No.	- -	- -
Stockwater wells	No.	- -	- -
Fencing	Miles	- -	- -
Driveways and driftways	Miles	- -	- -
Misc. stock handling facilities	No.	- -	- -
Miscellaneous			
Rodent control	Acres	- -	- -
Insect control	Acres	- -	- -
Weed control	Acres	- -	- -

TABLE IV-B-1 Public (State) (Idaho)

Measures	Unit	Total Needed Quantity (Units)	Program Cost (Dollars)
FOREST RESOURCES MEASURES			
Management Improvement			
Planting forest trees	Acres	- -	- -
Improvement of stands	Acres	- -	- -
Forest Protection (except fire)			
Insect control	Acres	- -	- -
Forest disease control	Acres	- -	- -
Rodent control	Acres	- -	- -
Fire Control Improvements (protection)	Dollars	- -	- -
MEASURES NOT ASSOCIATED WITH ONE LAND USE			
Fish & Wildlife Resource Measures			
Cover and food plantings	Acres	- -	- -
Water developments	No.	- -	- -
Fencing	Miles	- -	- -
Habitat improvement-streams	Miles	- -	- -
Habitat improvement-lakes	Acres	- -	- -
Hatcheries and pond projects	No.	- -	- -
Other			
Stabilizing dunes and blowouts	Acres	- -	- -
Stream pollution control	No.	- -	- -
Stabilizing waterways and outlets	Miles	- -	- -
Erosion and drainage control on roads and trails	Miles	- -	- -
Stabilizing slips and slides	Acres	- -	- -
Severe sheet erosion control (public)	Acres	- -	- -
ADMINISTRATIVE & MANAGEMENT MEASURES			
Technical Services (private,crop,range)	Dollars	- -	- -
Resource Development Plans	Acres	- -	- -
Transportation Facilities			
Roads	Miles	- -	- -
Trails	Miles	- -	- -
Airplane fields	No.	- -	- -
Helicopter spots	No.	- -	- -
Communication Facilities			
Telephone lines	Miles	- -	- -
Radio installation	No.	- -	- -
Buildings			
Dwellings, dormitories and misc.	No.	- -	- -
Offices	No.	- -	- -
Warehouses, garages and utility	No.	- -	- -
Water and Sanitary Systems			
Water systems	No.	- -	- -
Sanitary systems	No.	- -	- -
Recreation Facilities			
Camp & picnic areas - family units	No.	- -	- -
Shelters and bath houses	No.	- -	- -
Winter sports areas	No.	- -	- -
Misc. recreation facilities	No.	- -	- -
Clean-up and disposal projects	No.	- -	- -
Miscellaneous Management Facilities	Dollars	- -	- -
Purchase or Exchange of Land	Acres	- -	- -
Grounds Development & Small Structures	No.	- -	- -

TABLE IV-B-2 Quantities and Annual Costs -- Recurring Measures

For Public (State) In Big Bend-Palouse-Lower Snake (Idaho)

Measures	Total Annual Needed Program Quantity	Cost
	(Acres)	(Dollars)
CROPLAND MEASURES		
Contour farming	0	0
Crop residue utilization	32	96
Subsoiling	30	240
Other tilling	0	0
Green manuring & cover cropping	32	320
Rotation seedings	23	276
Pasture seeding	4	60
Pasture management	46	198
Liming	0	0
Fertilizing		
To establish soil conserving crops	0	0
To increase production	0	0
Improving water application	0	0
Correcting soil salinity	0	0
RANGE RESOURCE MEASURES		
Proper stocking	0	0
Deferred grazing	0	0
Fire protection	0	0
FOREST RESOURCES MEASURES		
Fire protection, organization and equipment	-	-
ADMINISTRATIVE & MANAGEMENT MEASURES		
Intensified management	-	-
Technical assistance on forest land	-	-

TABLE IV-B-2a Recurring Annual Operation, Maintenance & Replacement Costs

For Public (State) In Big Bend-Palouse-Lower Snake (Idaho)

Kind of Measures	Total Annual Needed Program
	(Dollars)
Cropland Measures	10
Range Resource Measures	0
Forest Land Resource Measures	-
Measures Not Associated with One Land Use	0
Administrative & Management Measures	-

TABLE IV-B-1 Quantities and Installation Costs - Non-Recurring Measures

For Public & Private In Big Bend-Palouse-Lower Snake (Washington)

Measures	Unit	Total Needed Program Quantity (Units)	Cost (Dollars)
CROPLAND MEASURES			
Soil Protection and Improvement			
Contour stripping and planting	Acres	1,002,300	1,052,400
Terracing	Miles	454	45,400
Field diversions	Miles	1,000	201,000
Field strip cropping	Acres	761,555	228,465
Drainage Improvement			
Individual farm drains	Acres	84,430	579,000
Community systems	Miles	15	50,000
Irrigated Land Treatment			
Preparing land for irrigation	Acres	964,000	53,020,000
Improving farm irrigation systems	Acres	30,000	600,000
Improving trunk line systems	Acres	8,000	80,000
Developing irrigation facilities	No.	1,400	1,400,000
New farm irrigation systems	No.	14,000	70,000,000
Miscellaneous			
Farm ponds	No.	1,200	1,200,000
Wildlife areas	Acres	26,255	2,080,200
Liquid manure tanks	No.	60	120,000
Cleanup clearing	Acres	20,000	200,000
Weed control	Acres	176,000	1,232,000
Fire protection	Acres	3,673,000	202,000
Rodent control	Acres	216,340	324,510
Insect control	Acres	69,600	487,200
Windbreak & shelter belt planting	Acres	10,000	350,000
Clearing forest land	Acres	350	14,000
RANGE RESOURCE MEASURES			
Cover Improvement and Protection			
Seeding and planting	Acres	664,800	6,318,100
Protective fencing	Miles	310	108,850
Sagebrush & other woody plant control	Acres	376,600	1,129,400
Water spreading & irrigation	Acres	10,600	205,000
Fertilizing	Acres	424,300	2,156,000
Management Improvement			
Exclusion	Acres	604,000	0
Improvement of Livestock Distribution and Management			
Water storage facilities	No.	1,800	864,550
Springs and seeps	No.	1,035	311,000
Stockwater wells	No.	600	899,000
Fencing	Miles	1,600	1,158,600
Driveways and driftways	Miles	156	57,400
Misc. stock handling facilities	No.	110	79,900
Miscellaneous			
Rodent control	Acres	106,000	69,300
Insect control	Acres	91,200	81,700
Weed control	Acres	180,600	1,109,800

TABLE IV-B-1 Public & Private (Washington)

Measures	Unit	Total Needed Program Quantity (Units)	Total Needed Program Cost (Dollars)
FOREST RESOURCES MEASURES			
Management Improvement			
Planting forest trees	Acres	24,700	864,750
Improvement of stands	Acres	39,300	786,000
Forest Protection (except fire)			
Insect control	Acres	19,700	197,100
Forest disease control	Acres	- -	23,800
Rodent control	Acres	34,000	17,000
Fire Control Improvements(protection)	Dollars	- -	217,350
MEASURES NOT ASSOCIATED WITH ONE LAND USE			
Fish & Wildlife Resource Measures			
Cover and food plantings	Acres	10,700	153,900
Water developments	No.	66	1,763,000
Fencing	Miles	130	130,000
Habitat improvement-streams	Miles	44	26,370
Habitat improvement-lakes	Acres	60	1,530
Hatcheries and pond projects	No.	8	288,000
Other			
Stabilizing dunes and blowouts	Acres	1,135	254,000
Stream pollution control	No.	0	0
Stabilizing waterways and outlets	Miles	17,700	21,759,350
Erosion and drainage control on roads and trails	Miles	501	185,000
Stabilizing slips and slides	Acres	1,000	200,000
Severe sheet erosion control(public)	Acres	5,000	251,000
ADMINISTRATIVE & MANAGEMENT MEASURES			
Technical Services(private crop,range)	Dollars	- -	- -
Resource Development Plans	Acres	7,693,800	166,300
Transportation Facilities			
Roads	Miles	310	5,306,390
Trails	Miles	300	285,500
Airplane fields	No.	3	100,000
Helicopter spots	No.	22	5,400
Communication Facilities			
Telephone lines	Miles	58	61,340
Radio installation	No.	30	28,200
Buildings			
Dwellings, dormitories and misc.	No.	34	420,480
Offices	No.	5	41,000
Warehouses, garages and utility	No.	52	242,380
Water and Sanitary Systems			
Water systems	No.	18	86,000
Sanitary systems	No.	18	61,000
Recreation Facilities			
Camp & picnic areas - family units	No.	326	234,380
Shelters and bath houses	No.	1	1,200
Winter sports areas	No.	- -	- -
Misc. recreation facilities	No.	3	3,000
Clean-up and disposal projects	No.	- -	56,250
Miscellaneous Management Facilities	Dollars	- -	76,420
Purchase or Exchange of Land	Acres	92,760	2,136,510
Grounds Development & Small Structures	No.	12	52,900

TABLE IV-B-2 Quantities and Annual Costs -- Recurring Measures

For Public & Private In Big Bend-Palouse-Lower Snake (Washington)

Measures	Total Annual Quantity (Acres)	Needed Program Cost (Dollars)
CROPLAND MEASURES		
Contour farming	1,638,920	409,730
Crop residue utilization	1,946,980	5,934,940
Subsoiling	79,440	635,530
Other tilling	816,050	816,050
Green manuring & cover cropping	275,120	2,751,180
Rotation seedings	230,640	2,767,700
Pasture seeding	38,920	583,785
Pasture management	607,200	1,821,615
Liming	1,200	18,000
Fertilizing		
To establish soil conserving crops	6,740	80,850
To increase production	1,242,990	22,373,820
Improving water application	1,059,000	0
Correcting soil salinity	3,200	48,000
RANGE RESOURCE MEASURES		
Proper stocking	1,923,000	96,150
Deferred grazing	833,300	83,300
Fire protection	2,862,000	85,860
FOREST RESOURCES MEASURES		
Fire protection, organization and equipment	0	43,100
ADMINISTRATIVE & MANAGEMENT MEASURES		
Intensified management	0	68,400
Technical assistance on forest land	0	5,200

TABLE IV-B-2a Recurring Annual Operation, Maintenance & Replacement Costs

For Public & Private In Big Bend-Palouse-Lower Snake (Washington)

Kind of Measures	Total Annual Needed Program (Dollars)
Cropland Measures	6,357,270
Range Resource Measures	685,380
Forest Land Resource Measures	80,400
Measures Not Associated with One Land Use	349,000
Administrative & Management Measures	75,600

TABLE IV-B-1 Quantities and Installation Costs - Non-Recurring Measures

For Private In Big Bend-Palouse-Lower Snake (Washington)

Measures	Unit	Total Needed Program Quantity (Units)	Total Needed Program Cost (Dollars)
CROPLAND MEASURES			
Soil Protection and Improvement			
Contour stripping and planting	Acres	978,400	1,027,300
Terracing	Miles	450	45,000
Field diversions	Miles	1,000	200,000
Field strip cropping	Acres	745,000	223,500
Drainage Improvement			
Individual farm drains	Acres	80,000	575,000
Community systems	Miles	15	50,000
Irrigated Land Treatment			
Preparing land for irrigation	Acres	964,000	53,020,000
Improving farm irrigation systems	Acres	30,000	600,000
Improving trunk line systems	Acres	8,000	80,000
Developing irrigation facilities	No.	1,400	1,400,000
New farm irrigation systems	No.	14,000	70,000,000
Miscellaneous			
Farm ponds	No.	1,200	1,200,000
Wildlife areas	Acres	26,000	2,080,000
Liquid manure tanks	No.	60	120,000
Cleanup clearing	Acres	20,000	200,000
Weed control	Acres	172,000	1,204,000
Fire protection	Acres	3,673,000	202,000
Rodent control	Acres	209,915	314,875
Insect control	Acres	68,400	478,800
Windbreak & shelter belt planting	Acres	10,000	350,000
Clearing forest land	Acres	350	14,000
RANGE RESOURCE MEASURES			
Cover Improvement and Protection			
Seeding and planting	Acres	611,000	5,732,000
Protective fencing	Miles	310	108,850
Sagebrush & other woody plant control	Acres	376,600	1,129,400
Water spreading & irrigation	Acres	4,000	40,000
Fertilizing	Acres	422,000	2,110,000
Management Improvement			
Exclusion	Acres	606,000	0
Improvement of Livestock Distribution and Management			
Water storage facilities	No.	1,600	780,950
Springs and seeps	No.	1,035	311,000
Stockwater wells	No.	600	899,000
Fencing	Miles	1,300	867,000
Driveways and driftways	Miles	110	44,000
Misc. stock handling facilities	No.	0	0
Miscellaneous			
Rodent control	Acres	49,800	24,900
Insect control	Acres	50,400	45,000
Weed control	Acres	172,800	1,038,400

TABLE IV-B-1 Private

Measures	Unit	Total Needed Program Quantity	Cost
FOREST RESOURCES MEASURES		(Units)	(Dollars)
Management Improvement			
Planting forest trees	Acres	22,000	770,000
Improvement of stands	Acres	28,900	578,000
Forest Protection (except fire)			
Insect control	Acres	4,800	47,800
Forest disease control	Acres	- -	8,000
Rodent control	Acres	9,400	4,700
Fire Control Improvements(protection)	Dollars	- -	21,600
MEASURES NOT ASSOCIATED WITH ONE LAND USE			
Fish & Wildlife Resource Measures			
Cover and food plantings	Acres	- -	- -
Water developments	No.	- -	- -
Fencing	Miles	- -	- -
Habitat improvement-streams	Miles	- -	- -
Habitat improvement-lakes	Acres	- -	- -
Hatcheries and pond projects	No.	- -	- -
Other			
Stabilizing dunes and blowouts	Acres	35	7,000
Stream pollution control	No.	- -	- -
Stabilizing waterways and outlets	Miles	18,000	2,179,350
Erosion and drainage control on roads and trails	Miles	81	30,400
Stabilizing slips and slides	Acres	900	101,000
Severe sheet erosion control(public)	Acres	600	30,000
ADMINISTRATIVE & MANAGEMENT MEASURES			
Technical Services(private crop,range)	Dollars	- -	- -
Resource Development Plans	Acres	738,000	8,190
Transportation Facilities			
Roads	Miles	- -	- -
Trails	Miles	- -	- -
Airplane fields	No.	- -	- -
Helicopter spots	No.	- -	- -
Communication Facilities			
Telephone lines	Miles	4	440
Radio installation	No.	3	2,700
Buildings			
Dwellings, dormitories and misc.	No.	1	12,000
Offices	No.	- -	- -
Warehouses, garages and utility	No.	4	16,550
Water and Sanitary Systems			
Water systems	No.	1	4,000
Sanitary systems	No.	1	3,000
Recreation Facilities			
Camp & picnic areas - family units	No.	- -	- -
Shelters and bath houses	No.	- -	- -
Winter sports areas	No.	- -	- -
Misc. recreation facilities	No.	- -	- -
Clean-up and disposal projects	No.	- -	- -
Miscellaneous Management Facilities	Dollars	- -	- -
Purchase or Exchange of Land	Acres	- -	- -
Grounds Development & Small Structures	No.	1	4,000

TABLE IV-B-2 Quantities and Annual Costs — Recurring Measures

For Private In Big Bend-Palouse-Lower Snake (Washington)

Measures	Total Annual Needed Program Quantity (Acres)	Cost (Dollars)
CROPLAND MEASURES		
Contour farming	1,608,000	402,000
Crop residue utilization	1,914,000	5,836,000
Subsoiling	77,200	617,600
Other tilling	791,500	791,500
Green manuring & cover cropping	269,250	2,692,500
Rotation seedings	223,125	2,677,500
Pasture seeding	38,330	574,995
Pasture management	600,000	1,800,000
Liming	1,200	18,000
Fertilizing		
To establish soil conserving crops	6,740	80,845
To increase production	1,242,990	22,373,820
Improving water application	1,059,000	0
Correcting soil salinity	3,200	48,000
RANGE RESOURCE MEASURES		
Proper stocking	1,923,000	96,150
Deferred grazing	833,300	83,300
Fire protection	2,862,000	85,860
FOREST RESOURCES MEASURES		
Fire protection, organization and equipment	- -	24,400
ADMINISTRATIVE & MANAGEMENT MEASURES		
Intensified management	- -	- -
Technical assistance on forest land	- -	5,200

TABLE IV-B-2a Recurring Annual Operation, Maintenance & Replacement Costs

For Private In Big Bend-Palouse-Lower Snake (Washington)

Kind of Measures	Total Annual Needed Program (Dollars)
Cropland Measures	6,338,400
Range Resource Measures	658,500
Forest Land Resource Measures	40,200
Measures Not Associated with One Land Use	5,200
Administrative & Management Measures	349,000

TABLE IV-B-1 Quantities and Installation Costs - Non-Recurring Measures

For Public (USDA) In Big Bend-Palouse-Lower Snake (Washington)

Measures		Total Needed Program Quantity (Units)	Total Needed Program Cost (Dollars)
CROPLAND MEASURES			
Soil Protection and Improvement			
Contour stripping and planting	Acres	- -	- -
Terracing	Miles	- -	- -
Field diversions	Miles	- -	- -
Field strip cropping	Acres	- -	- -
Drainage Improvement			
Individual farm drains	Acres	- -	- -
Community systems	Miles	- -	- -
Irrigated Land Treatment			
Preparing land for irrigation	Acres	- -	- -
Improving farm irrigation systems	Acres	- -	- -
Improving trunk line systems	Acres	- -	- -
Developing irrigation facilities	No.	- -	- -
New farm irrigation systems	No.	- -	- -
Miscellaneous			
Farm ponds	No.	- -	- -
Wildlife areas	Acres	- -	- -
Liquid manure tanks	No.	- -	- -
Cleanup clearing	Acres	- -	- -
Weed control	Acres	- -	- -
Fire protection	Acres	- -	- -
Rodent control	Acres	- -	- -
Insect control	Acres	- -	- -
Windbreak & shelter belt planting	Acres	- -	- -
Clearing forest land	Acres	- -	- -
RANGE RESOURCE MEASURES			
Cover Improvement and Protection			
Seeding and planting	Acres	3,900	42,000
Protective fencing	Miles	- -	- -
Sagebrush & other woody plant control	Acres	- -	- -
Water spreading & irrigation	Acres	- -	- -
Fertilizing	Acres	1,500	30,000
Management Improvement			
Exclusion	Acres	- -	- -
Improvement of Livestock Distribution and Management			
Water storage facilities	No.)	38	17,000
Springs and seeps	No.)		
Stockwater wells	No.	- -	- -
Fencing	Miles	51	57,700
Driveways and driftways	Miles	19	5,640
Misc. stock handling facilities	No.	19	13,900
Miscellaneous			
Rodent control	Acres	3,360	1,680
Insect control	Acres	8,670	7,800
Weed control	Acres	900	7,050

TABLE IV-B-1 Public (USDA) Big Bend-Palouse-Lower Snake (Washington)

Measures	Unit	Total Needed Quantity	Program Cost
FOREST RESOURCES MEASURES		(Units)	(Dollars)
Management Improvement			
Planting forest trees	Acres	2,260	79,000
Improvement of stands	Acres	9,700	194,000
Forest Protection (except fire)			
Insect control	Acres	8,370	83,700
Forest disease control	Acres	- -	15,300
Rodent control	Acres	20,000	10,000
Fire Control Improvements(protection)	Dollars	- -	179,850
MEASURES NOT ASSOCIATED WITH ONE LAND USE			
Fish & Wildlife Resource Measures			
Cover and food plantings	Acres	5,040	75,660
Water developments	No.	- -	- -
Fencing	Miles	- -	- -
Habitat improvement-streams	Miles	19	5,370
Habitat improvement-lakes	Acres	60	1,530
Hatcheries and pond projects	No.	- -	- -
Other			
Stabilizing dunes and blowouts	Acres	- -	- -
Stream pollution control	No.	- -	- -
Stabilizing waterways and outlets	Miles	- -	- -
Erosion and drainage control on roads and trails	Miles	187	70,000
Stabilizing slips and slides	Acres	11	51,400
Severe sheet erosion control(public)	Acres	1,400	71,000
ADMINISTRATIVE & MANAGEMENT MEASURES			
Technical Services(private crop,range)	Dollars	- -	- -
Resource Development Plans	Acres	5,406,000	81,100
Transportation Facilities			
Roads	Miles	218	3,736,000
Trails	Miles	269	256,500
Airplane fields	No.	1	40,000
Helicopter spots	No.	22	5,400
Communication Facilities			
Telephone lines	Miles	26	28,300
Radio installation	No.	15	13,800
Buildings			
Dwellings, dormitories and misc.	No.	15	163,680
Offices	No.	3	20,000
Warehouses, garages and utility	No.	25	93,430
Water and Sanitary Systems			
Water systems	No.	12	48,000
Sanitary systems	No.	12	35,000
Recreation Facilities			
Camp & picnic areas - family units	No.	302	213,130
Shelters and bath houses	No.	- -	- -
Winter sports areas	No.	- -	- -
Misc. recreation facilities	No.	3	3,000
Clean-up and disposal projects	No.	- -	24,250
Miscellaneous Management Facilities	Dollars	- -	31,820
Purchase or Exchange of Land	Acres	14,000	88,300
Grounds Development & Small Structures	No.	7	28,000

TABLE IV-B-2 Quantities and Annual Costs -- Recurring Measures

For Public (USDA) In Big Bend-Palouse-Lower Snake (Washington)

Measures	Total Annual Needed Program Quantity	Cost
	(Acres)	(Dollars)
CROPLAND MEASURES		
Contour farming	--	--
Crop residue utilization	--	--
Subsoiling	--	--
Other tilling	--	--
Green manuring & cover cropping	--	--
Rotation seedings	--	--
Pasture seeding	--	--
Pasture management	--	--
Liming	--	--
Fertilizing		
To establish soil conserving crops	--	--
To increase production	--	--
Improving water application	--	--
Correcting soil salinity	--	--
RANGE RESOURCE MEASURES		
Proper stocking	--	--
Deferred grazing	--	--
Fire protection	--	--
FOREST RESOURCES MEASURES		
Fire protection, organization and equipment	--	13,300
ADMINISTRATIVE & MANAGEMENT MEASURES		
Intensified management	--	51,800
Technical assistance on forest land		

TABLE IV-B-2a Recurring Annual Operation, Maintenance & Replacement Costs

For Public (USDA) In Big Bend-Palouse-Lower Snake(Washington)

Kind of Measures	Total Annual Needed Program (Dollars)
Cropland Measures	--
Range Resource Measures	4,700
Forest Land Resource Measures	33,700
Measures Not Associated with One Land Use	--
Administrative & Management Measures	67,100

TABLE IV-B-1 Quantities and Installation Costs - Non-Recurring Measures

For Public (USDI) In Big Bend-Palouse-Lower Snake (Washington)

Measures	Unit	Total Needed Program Quantity (Units)	Cost (Dollars)
CROPLAND MEASURES			
Soil Protection and Improvement			
Contour stripping and planting	Acres	- -	- -
Terracing	Miles	- -	- -
Field diversions	Miles	- -	- -
Field strip cropping	Acres	- -	- -
Drainage Improvement			
Individual farm drains	Acres	- -	- -
Community systems	Miles	- -	- -
Irrigated Land Treatment			
Preparing land for irrigation	Acres	- -	- -
Improving farm irrigation systems	Acres	- -	- -
Improving trunk line systems	Acres	- -	- -
Developing irrigation facilities	No.	- -	- -
New farm irrigation systems	No.	- -	- -
Miscellaneous			
Farm ponds	No.	- -	- -
Wildlife areas	Acres	- -	- -
Liquid manure tanks	No.	- -	- -
Cleanup clearing	Acres	- -	- -
Weed control	Acres	- -	- -
Fire protection	Acres	- -	- -
Rodent control	Acres	- -	- -
Insect control	Acres	- -	- -
Windbreak & shelter belt planting	Acres	- -	- -
Clearing forest land	Acres	- -	- -
RANGE RESOURCE MEASURES			
Cover Improvement and Protection			
Seeding and planting	Acres	15,000	125,000
Protective fencing	Miles	- -	- -
Sagebrush & other woody plant control	Acres	- -	- -
Water spreading & irrigation	Acres	6,600	165,000
Fertilizing	Acres	- -	- -
Management Improvement			
Exclusion	Acres	- -	- -
Improvement of Livestock Distribution and Management			
Water storage facilities	No.)	36	16,200
Springs and seeps	No.)		
Stockwater wells	No.	1	1,000
Fencing	Miles	88	52,800
Driveways and driftways	Miles	- -	- -
Misc. stock handling facilities	No.	34	25,500
Miscellaneous			
Rodent control	Acres	39,000	35,800
Insect control	acres	20,300	18,300
Weed control	Acres	4,400	44,000

TABLE IV-B-1 Public (USDI) (Washington)

Measures	Unit	Total Needed Program Quantity (Units)	Cost (Dollars)
FOREST RESOURCES MEASURES			
Management Improvement			
Planting forest trees	Acres	- -	- -
Improvement of stands	Acres	- -	- -
Forest Protection (except fire)			
Insect control	Acres	100	1,000
Forest disease control	Acres	- -	- -
Rodent control	Acres	- -	- -
Fire Control Improvements (protection)	Dollars	- -	15,000
MEASURES NOT ASSOCIATED WITH ONE LAND USE			
Fish & Wildlife Resource Measures			
Cover and food plantings	Acres	5,200	76,000
Water developments	No.	66	1,763,000
Fencing	Miles	130	130,000
Habitat improvement-streams	Miles	4	2,400
Habitat improvement-lakes	Acres	- -	- -
Hatcheries and pond projects	No.	- -	- -
Other			
Stabilizing dunes and blowouts	Acres	1,000	227,000
Stream pollution control	No.	- -	- -
Stabilizing waterways and outlets	Miles	- -	- -
Erosion and drainage control on roads and trails	Miles	50	16,000
Stabilizing slips and slides	Acres	- -	- -
Severe sheet erosion control (public)	Acres	1,500	75,000
ADMINISTRATIVE & MANAGEMENT MEASURES			
Technical Services (private crop, range)	Dollars	- -	- -
Resource Development Plans	Acres	1,367,000	57,400
Transportation Facilities			
Roads	Miles	60	992,000
Trails	Miles	10	10,000
Airplane fields	No.	2	60,000
Helicopter spots	No.	- -	- -
Communication Facilities			
Telephone lines	Miles	24	26,400
Radio installation	No.	8	7,200
Buildings			
Dwellings, dormitories and misc.	No.	14	197,300
Offices	No.	2	21,000
Warehouses, garages and utility	No.	21	127,400
Water and Sanitary Systems			
Water systems	No.	4	30,000
Sanitary systems	No.	4	20,000
Recreation Facilities			
Camp & picnic areas - family units	No.	17	15,300
Shelters and bath houses	No.	1	1,200
Winter sports areas	No.	- -	- -
Misc. recreation facilities	No.	- -	- -
Clean-up and disposal projects	No.	- -	- -
Miscellaneous Management Facilities	Dollars	- -	32,000
Purchase or Exchange of Land	Acres	- -	44,100
Grounds Development & Small Structures	No.	78,300	2,022,200
		4	20,000

TABLE IV-B-2 Quantities and Annual Costs -- Recurring Measures

For Public (USDI) In Big Bend-Palouse-Lower Snake (Washington)

Measures	Total Annual Needed Program Quantity (Acres)	Cost (Dollars)
CROPLAND MEASURES		
Contour farming	- -	- -
Crop residue utilization	- -	- -
Subsoiling	- -	- -
Other tilling	- -	- -
Green manuring & cover cropping	- -	- -
Rotation seedings	- -	- -
Pasture seeding	- -	- -
Pasture management	- -	- -
Liming	- -	- -
Fertilizing		
To establish soil conserving crops	- -	- -
To increase production	- -	- -
Improving water application	- -	- -
Correcting soil salinity	- -	- -
RANGE RESOURCE MEASURES		
Proper stocking	- -	- -
Deferred grazing	- -	- -
Fire protection	- -	- -
FOREST RESOURCES MEASURES		
Fire protection, organization and equipment	- -	3,700
ADMINISTRATIVE & MANAGEMENT MEASURES		
Intensified management	- -	16,600
Technical assistance on forest land	- -	- -

TABLE IV-B-2a Recurring Annual Operation, Maintenance & Replacement Costs

For Public (USDI) In Big Bend-Palouse-Lower Snake (Washington)

Kind of Measures	Total Annual Needed Program (Dollars)
Cropland Measures	- -
Range Resource Measures	5,200
Forest Land Resource Measures	3,700
Measures Not Associated with One Land Use	- -
Administrative & Management Measures	3,300

TABLE IV-B-1 Quantities and Installation Costs - Non-Recurring Measures

For Public (State) In Big Bend-Palouse-Lower Snake (Washington)

Measures	Unit	Total Needed Program Quantity	Cost
		(Units)	(Dollars)
CROPLAND MEASURES			
Soil Protection and Improvement			
Contour stripping and planting	Acres	23,900	25,100
Terracing	Miles	4	400
Field diversions	Miles	5	1,000
Field strip cropping	Acres	16,555	4,965
Drainage Improvement			
Individual farm drains	Acres	4,430	14,000
Community systems	Miles	0	0
Irrigated Land Treatment			
Preparing land for irrigation	Acres	0	0
Improving farm irrigation systems	Acres	0	0
Improving trunk line systems	Acres	0	0
Developing irrigation facilities	No.	0	0
New farm irrigation systems	No.	0	0
Miscellaneous			
Farm ponds	No.	12	12,000
Wildlife areas	Acres	255	204
Liquid manure tanks	No.	0	0
Cleanup clearing	Acres	0	0
Weed control	Acres	4,000	28,000
Fire protection	Acres	0	0
Rodent control	Acres	4,284	6,426
Insect control	Acres	1,200	8,400
Windbreak & shelter belt planting	Acres	0	0
Clearing forest land	Acres	- -	- -
RANGE RESOURCE MEASURES			
Cover Improvement and Protection			
Seeding and planting	Acres	34,900	419,100
Protective fencing	Miles	- -	- -
Sagebrush & other woody plant control	Acres	- -	- -
Water spreading & irrigation	Acres	- -	- -
Fertilizing	Acres	800	16,000
Management Improvement			
Exclusion	Acres	0	0
Improvement of Livestock Distribution and Management			
Water storage facilities	No.	112	50,400
Springs and seeps	No.	- -	- -
Stockwater wells	No.	- -	- -
Fencing	Miles	161	181,100
Driveways and driftways	Miles	26	7,800
Misc. stock handling facilities	No.	54	40,500
Miscellaneous			
Rodent control	Acres	13,800	6,900
Insect control	Acres	11,800	10,600
Weed control	Acres	2,500	20,300

TABLE IV-B-1 Public (State) (Washington)

Measures	Unit	Total Needed Program Quantity (Units)	Cost (Dollars)
FOREST RESOURCES MEASURES			
Management Improvement			
Planting forest trees	Acres	450	15,750
Improvement of stands	Acres	700	14,000
Forest Protection (Except fire)			
Insect control	Acres	6,450	64,600
Forest disease control	Acres	122	500
Rodent control	Acres	4,600	2,300
Fire Control Improvements(protection)	Dollars	- -	900
MEASURES NOT ASSOCIATED WITH ONE LAND USE			
Fish & Wildlife Resource Measures			
Cover and food plantings	Acres	450	2,250
Water developments	No.	- -	- -
Fencing	Miles	- -	- -
Habitat improvement-streams	Miles	31	18,600
Habitat improvement-lakes	Acres	- -	- -
Hatcheries and pond projects	No.	8	288,000
Other			
Stabilizing dunes and blowouts	Acres	100	20,000
Stream pollution control	No.	- -	- -
Stabilizing waterways and outlets	Miles	- -	- -
Erosion and drainage control on roads and trails	Miles	183	68,630
Stabilizing slips and slides	Acres	70	30,700
Severe sheet erosion control (public)	Acres	1,500	75,000
ADMINISTRATIVE & MANAGEMENT MEASURES			
Technical Services (private crop,range)	Dollars	182,800	19,630
Resource Development Plans	Acres		
Transportation Facilities			
Roads	Miles	33	578,400
Trails	Miles	19	19,000
Airplane fields	No.	- -	- -
Helicopter spots	No.	- -	- -
Communication Facilities			
Telephone lines	Miles	2	2,200
Radio installation	No.	5	4,500
Buildings			
Dwellings, dormitories and misc.	No.	4	47,500
Offices	No.	- -	- -
Warehouses, garages and utility	No.	2	5,000
Water and Sanitary Systems			
Water systems	No.	1	4,000
Sanitary systems	No.	1	3,000
Recreation Facilities			
Camp & picnic areas - family units	No.	7	5,950
Shelters and bath houses	No.	- -	- -
Winter sports areas	No.	- -	- -
Misc. recreation facilities	No.	- -	- -
Clean-up and disposal projects	No.	- -	- -
Miscellaneous Management Facilities	Dollars	- -	500
Purchase or Exchange of Land	Acres	460	26,020
Grounds Development & Small Structures	No.	- -	- -

TABLE IV-B-2 Quantities and Annual Costs -- Recurring Measures

For Public (State) In Big Bend-Palouse-Lower Snake (Washington)

Measures	Total Annual Needed Program Quantity	Cost
	(Acres)	(Dollars)
CROPLAND MEASURES		
Contour farming	30,920	7,730
Crop residue utilization	32,980	98,940
Subsoiling	2,240	17,928
Other tilling	24,550	24,550
Green manuring & cover cropping	5,868	58,680
Rotation seedings	7,520	90,200
Pasture seeding	600	8,800
Pasture management	7,200	21,600
Liming	0	0
Fertilizing		
To establish soil conserving crops	0	0
To increase production	0	0
Improving water application	0	0
Correcting soil salinity	0	0
RANGE RESOURCE MEASURES		
Proper stocking	0	0
Deferred grazing	0	0
Fire protection	--	--
FOREST RESOURCES MEASURES		
Fire protection, organization and equipment	--	1,700
ADMINISTRATIVE & MANAGEMENT MEASURES		
Intensified management	--	--
Technical assistance on forest land	--	--

TABLE IV-B-2a Recurring Annual Operation, Maintenance & Replacement Costs

For Public (State) In Big Bend-Palouse-Lower Snake (Washington)

Kind of Measures	Total Annual Needed Program
	(Dollars)
Cropland Measures	18,913
Range Resource Measures	17,000
Forest Land Resource Measures	2,800
Measures Not Associated with One Land Use	0
Administrative & Management Measures	--

CHAPTER V

FLOOD PREVENTION PROBLEMS, PROGRAM AND EVALUATION

CONTENTS

CHAPTER V

CONTENTS
(continued)

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INTRODUCTION

AUTHORITY

This report is submitted under the provisions of the Flood Control Act approved June 22, 1936 (49 Stat. 1570), as amended and supplemented.

SCOPE

This report outlines a program of watershed treatment for runoff and waterflow retardation and soil erosion prevention needed in the Big Bend-Palouse-Lower Snake Area. It is mainly in southeastern Washington with small segments in northwestern Idaho and northeastern Oregon. It includes an area of about 15,780 square miles or 10,100,000 acres.

The watershed program is composed of two groups of measures. One group consists of measures primarily for flood prevention, hereinafter called flood prevention measures (A Measures), which are not normally being installed under existing authorities for current national programs of the Department of Agriculture. The other group consists of measures used for the conservation of watershed lands which contribute directly to flood prevention, hereinafter called land treatment measures (B Measures), and which are being installed under existing authorities for such programs.

This report presents recommendations for the authorization of the flood prevention measures, under the Flood Control Act of June 22, 1936, as amended and supplemented, and for installation of the land treatment measures under existing authorities concurrently with the flood prevention measures.

NEED FOR THE WATERSHED PROGRAM

The program recommended in this report affects the welfare of about 77,000 rural, and 91,000 urban people living within the area. The estimated average annual floodwater and sediment damages for the area total approximately $2,600,000. These damages are caused about equally by floodwater and sedimentation. If other losses such as disease epidemics, dislocations that result from floods, loss of labor, land abandonment, the lack of a stable farm income, and mental anguish caused by floods could be measured in dollars and cents, they would probably exceed the measurable losses.

About half of the damages determined in this area occur to crops as a result of flooding of the bottom lands, sedimentation and overland scour. The other major damage item is the destruction and increased maintenance of public roads and railroads as a result of flooding and sedimentation.

In the wheat producing sections of the area the steepness of the land, the susceptibility of the soil to erosion and the seasonal precipitation has resulted in severe erosion. This, in turn, has caused serious sedimentation problems of increased road maintenance and damage to crops. A continuation of this situation will reduce the effectiveness of the large dams now under construction or proposed for construction on the lower Columbia River. There is urgent need for land use adjustments and conservation measures that will prevent erosion and conserve moisture.

Forage production on the rangelands in the area is now much less than the full potential for these ranges. Present intensity

and character of grazing use in many instances will not permit sustained production, and plant cover on much of the rangeland is not satisfactory from the standpoint of watershed requirements.

RECOMMENDATIONS

It is recommended that a program for runoff and waterflow retardation and soil erosion prevention be installed during a 20-year period in the Big Bend-Palouse-Lower Snake Area of the Columbia River Basin at an estimated cost of $10,331,173 to the Federal government and $46,030,066 to non-Federal interests.[1]

The recommended program would be operated and maintained at an estimated annual cost of $241,500 to the Federal government, $158,200 or its equivalent [1] to other public agencies, and $10,696,400 or its equivalent[1] to private interests, making an estimated total annual cost of $11,096,100 for operating and maintaining the completed program.

The proposed program for flood prevention measures is summarized on Table V-3. The recommended land treatment program for cropland, rangeland and forest land is summarized in Table V-4.

Technical services, direct aids and educational assistance will be made available for planning and applying the conservation practices and measures included in the recommended program.

It is estimated that the recommended program will yield an average annual flood prevention benefit of $1,572,649. In addition to this flood prevention benefit, an estimated average annual

1/ Labor, materials, equipment, land easements, rights-of-way, and other contributions.

benefit of $20,522,126 from conservation farming, ranching and woodland management will accrue to land owners and operators in the watershed. Total estimated average annual benefits amount to $22,094,775.

The ratio of the average annual value of the benefits to the average annual equivalent value of the costs of the recommended program is 1.6 to 1.

DESCRIPTION OF THE WATERSHED

LOCATION AND SIZE

The Big Bend-Palouse-Lower Snake area of the Columbia River Basin is located mainly in southeastern Washington. It includes small segments of northwestern Idaho and northeastern Oregon. It has a roughly circular shape, the diameter being about 160 miles. It includes three major wheat producing areas, known locally as the Palouse, Big Bend and Walla Walla areas. The area contains about 15,664 square miles or 10,025,000 acres.

The area is bounded on the north by Lake Roosevelt (a lake created by Grand Coulee Dam), on the west by the Columbia River and on the south and east by the Blue and Moscow Mountains. The major streams draining the area are the Palouse, Walla Walla and Tucannon Rivers, Crab Creek and Moses and Grand Coulees. The Snake River enters the area at Lewiston, Idaho and flows westward across the southern portion until it joins the Columbia River near Pasco, Washington.

PHYSIOGRAPHY

In physiographical features the Big Bend-Palouse-Lower Snake

area is largely a plateau bounded on the north and western two-thirds by rivers and on the southeastern third by the Moscow Mountains of Idaho and the Blue Mountains of Washington and Oregon. Elevations above sea level vary from about 380 feet at the mouth of the Walla Walla River in the southwestern part to some 6500 feet at the Oregon Buttes in the Blue Mountains fringe on the east. The drainage pattern of all the area except the extreme northern edge is toward the southwest into the Snake and Columbia Rivers. In general this area might be visualized as a broad basaltic plateau overlaid by loessial type soils and dissected by ancient stream beds cut by glacial waters to form Moses Coulee, Grand Coulee and the channelled scablands. A plucking rather than an abrading type of geologic erosion through the basalt has left island mesas and cliff sided coulees. The largest of these is the Grand Coulee wherein 10 cubic miles of basalt are estimated to have been plucked out, resulting in a coulee 30 miles long with vertical cliff-like side walls. The retreating glacier left huge boulders, locally called "haystack rocks", on top of farm fields in Douglas County, and mounded moraines in lower Spokane County. Winds, predominantly from the southwest, have left a streaked, windblown, soil pattern in western Walla Walla County, steep sided hills to the north and the cone pocketed dune-like topography of the Palouse hills. A similar wind pattern influences the sand dunes of central Franklin County and the black sands and "potholes" south of Moses Lake in Grant County. The local names of "Michigan Prairie" and "Rattlesnake Flat" in central Adams County are descriptive of the gentle

slopes of much of the drier wheat land areas.

The cultivated lands of the Big Bend-Palouse-Lower Snake area are divided into (1) the irrigated river bottoms and narrow flood plains under 1000 feet in elevation which frequently have precipitation too low for crop production; (2) the dry wheat land area which extends from 800 to 2000 feet in elevation with precipitation from 8 to 15 inches, and where alternating summer fallow and wheat is the predominant cropping system; and (3) the more humid annual crop area, from 1700 to 3000 feet in elevation, which receives precipitation of 15 to 30 inches, making it possible to substitute legumes and nitrogen fertilizer for summer fallow in crop rotations and produce some of the highest field yields of wheat in the nation.

SOILS AND GEOLOGY

Geologic Features

The bedrock of the Big Bend-Palouse-Lower Snake area is basalt. This vast expanse of Columbia River basalt is the result of a series of lava flows which attain a maximum thickness of 5000 feet. However, along the northeastern and northwestern boundaries, bodies of granitic, metamorphic and sedimentary rocks ranging from Pre-Cambrian to lower Tertiary age, occur in a belt overlapped by the lava flows. The area is part of a larger structural basin which has been modified by deformation, erosion and deposition. The mantle of sediments overlying bedrock is the result of deposition of glacial outwash, loess, lacustrine sediments, alluvium and recent aeolian deposits. This mantle is considered to have an average depth of 50 feet but ranges from a few feet to more than 150 feet

in depth. In places alluvial and outwash gravels furnish moderate to large supplies of water to wells. Where the topography and structure is favorable, such as in the lower Palouse River drainage, large supplies of ground water sufficient for irrigation use is available from aquifers in the lava beds. Figure 3, Chapter II indicates the soil parent materials of this area.

Soil Characteristics

Glaciation and deposition occurring since Miocene time accounts for the glacial drift, alluvial, lacustrine and aeolian deposits which now cover much of the Big Bend-Palouse-Lower Snake area. The influence of volcanic ash windborne from the southwest has had a pronounced effect on soil textures over the region, often masking underlying features. The soils vary in texture, depth and subsoil characteristics depending upon their origin and aeolian cover. The deeper profiles extensively associated with the continental sediments which are largely of loessial origin are found in all parts of the basin, the largest area being in the central and eastern sections.

The western part shows a gradual thinning toward the shallow, light to coarse textured soil profiles. The channelled scablands and broad outwash channels are characterized by a very thin mantle of light to coarse textured soils with exposed areas of lava bedrock. Younger alluvial soils of variable depth and texture usually occur as narrow strips along stream channels.

CLIMATE

The climate of the area is, in general, temperate and largely semi-arid, although great differences in rainfall occur between the

higher and lower elevations. Seasonal distribution of rainfall likewise varies, with a winter wet season and a summer dry season. A semi-continental climate, characterized by wide temperature extremes, is predominant but is tempered somewhat by the mild westerly air currents from the Pacific Ocean. The relative humidity is low and there is an abundance of clear days.

Precipitation

Most precipitation in the area results from the eastward drift of cyclonic storms originating in the Pacific Ocean in the vicinity of the Aleutian Islands and passing inland along the Oregon-Washington coast. There is a semi-permanent anti-cyclonic high pressure area over the Pacific Ocean in the vicinity of the Hawaiian Islands. In the fall of the year this high pressure area drifts southward, permitting the cyclonic disturbances mentioned above to drift south and eastward, and to reach this area. In the spring of the year, the high pressure area drifts northward, shutting off the cyclonic storms. The topography of the area, however, is a factor which modifies the effect of these cyclonic disturbances. Storms from the Pacific Ocean rise to pass over the Cascade Mountains and in doing so lose moisture. In descending from the mountains into the Big Bend of the Columbia, the air becomes relatively drier. Consequently, over central Washington there is a preponderance of dry air and clear sky with scant precipitation of both rain and snow. East of the Columbia River there is a gradual increase in precipitation as air again rises to pass over the mountains to the east and is cooled in doing so.

The average annual precipitation varies from 6 inches near Pasco, Washington, to over 50 inches on the headwaters of the Walla Walla River in Oregon, and is more than 28 inches on the headwaters of the Palouse River in Idaho. Approximately 70% of the annual precipitation falls during the 6-month period October through March, much of it in the form of snow. Average annual snowfall at Ephrata is 17 inches. Average snow depth on April 1, at Tollgate snow survey course at the head of the Walla Walla River, is 68 inches. Extremes in 21 years of record at this snow course were 0 inches and 111 inches measured about April 1.

Snow storage is important as a source of irrigation water and in its potential as a flood hazard. In low areas snowfall remains on the ground only intermittently, but at higher elevations it accumulates during the winter months. Snow survey measurements show the average water content of the snow to be 27.4 inches on April 1 at the Tollgate snow course. The Sherwin, Idaho course, representative of the conditions on the headwaters of the Palouse, has an average snow depth of 34.6 inches on March 1, with an average water content of 11.2 inches.

Melting of the snowpack usually begins in March or April and continues through June at higher elevations. The rate of melt depends largely upon the prevailing temperatures and wind movement. The critical runoff period is from the middle of February through the last of May when rainstorms may coincide with rapid snowmelt.

The greatest amount of precipitation occurs in the fall, winter and spring months when warm moist air from the ocean moves inland. These storms are large in areal coverage and seldom exceed intensi-

ties of 1 inch in 24 hours. These disturbances frequently last for several days and when extended rains fall on saturated soils or on soils that are frozen beneath the surface, extensive erosion damages and moderately high stream flows occur. Summer precipitation results from storms characterized by heavy showers and occasional cloudbursts. These summer storms are unpredictable as to frequency, but their occurrence often results in considerable local damage to fields, crops, and property.

Temperature

Mean annual recorded temperatures vary from a minimum of 46.3° at Potlatch, Idaho, to 53.1° at Walla Walla, Washington. Extreme recorded temperatures vary from a high of 118° at Wahluke to a low of -36° at Potlatch. No temperature data are available for mountainous areas, but indications are that temperatures are considerably lower at altitudes higher than the weather stations.

Prevailing summer temperatures are relatively mild. In general, winter temperatures are not severe. The length of the frost-free growing season varies from 219 days at Walla Walla to 99 days at Wilbur, Washington and Potlatch, Idaho. Shorter growing seasons probably occur at higher altitudes where there are no weather records.

Wind, Evaporation and Transpiration

The average wind movement over the area is at low velocity, being the highest in the months of March, April, May and June. Dust storms are common during these months in areas of lighter textured soils. Maximum wind velocities reach 50 miles per hour during these

storms. Local topography has slight effect in determining the direction and force of surface winds, for most of the weather stations show a prevailing direction for the year from the southwest. The average annual velocity at Walla Walla is 5.6 miles per hour. Chinook winds, which are warm air currents, may occur at any season of the year, but the effects are most marked in winter when they may cause a temperature rise of 20 to 30° F. in fifteen minutes.

Evaporation is comparatively great during the summer owing to the very low humidities, the large amount of sunshine, and the periods of high temperature.

Transpiration rates of crops and other vegetation, greatest during the hot summer months, are moderate during the spring and fall months, and are negligible in the winter months when the plants are dormant. Consumptive use of water (evaporation and transpiration) for some irrigated crops in the hottest part of the area is more than 30 inches for the growing season.

LAND COVER

The Big Bend-Palouse-Lower Snake area was originally a vast grassland plateau fringed by forested mountains on the north, east and southeast. The first settlement in the area occurred about 100 years ago. Cattle growing and wheat production dominated the agricultural development from the date of settlement. Severe winters of 1881 and 1890 nearly wiped out the developing cattle industry and helped swing the preference to wheat growing. At about the turn of the century or shortly thereafter wheat production under an alternate crop-fallow system was extended to nearly all lands suitable to cultivation.

During the last two decades development of irrigation and annual cropping in areas with adequate rainfall has caused a diversification of land use in the eastern and western portions of the area. In 1950 approximately 50 percent of the area was used for cropland and about 2 percent of the cropland was irrigated.

Range lands accounted for about 42 percent of the area and are used for grazing sheep and cattle. The range lands occupy mainly the fringe areas, scablands and "breaks" along watercourses or coulees.

Forests now cover about 6 percent of the land area, being only slightly less extensive than when settlement first occurred.

The remaining 2 percent of the land area is occupied by roads, railroads, cities and towns or waste land.

ECONOMIC DEVELOPMENT

Population

The population of the area was 168,000 in 1950, or an increase of 85 percent since 1900. The growth has not been steady. Population increased by 62 percent from 1900 to 1910 but declined in numbers during the next two decades. In 1930, the population was 122,000, only 35 percent less than in 1950. Between 1940 and 1950 the population increased by 26 percent.

Agricultural Resources

In 1950 slightly less than 9,000 farms were reported in the area. The number of farms in this area has decreased almost steadily since 1910. In that year, the census reported 15,000 farms. Between

1940 and 1950, the number of farms decreased by 16 percent.

There are approximately 8.3 million acres of land in farms, of which more than 5 million acres are classified as cropland. The cropland represents 60 percent of the land in farms. The cropland is used predominantly for the production of wheat and other small grains. According to the 1950 U. S. Census of Agriculture, almost 5,400 farms, or 60 percent, were classified as field crop farms which produce grain as a cash crop. In addition to the farms producing grain as a cash crop, there were 700 livestock farms, 400 fruit farms, 300 dairy farms, 300 general, 160 poultry and 130 vegetable farms.

At the present time irrigation is of relatively minor importance in the area with irrigation reported on only 1,676 farms in 1950. These farms had a total of 137,000 acres of cropland harvested, but only 47,000 acres, or 35 percent, of this were irrigated.

This area is now undergoing significant changes. It is estimated that the Columbia Basin Irrigation Project of the Bureau of Reclamation will make irrigation water available from the Roosevelt Lake for a million acres of land in the Big Bend area. This will mean the creation of many new farm units and a change in land use from dry farming and range to intensive irrigated use.

FLOODWATER AND SEDIMENT PROBLEMS

Floodwater and sediment problems in the Big Bend-Palouse-Lower Snake area are due to three general types of flood occurrences. There are periodic floods on the main streams and floods of almost annual occurrence on small tributaries, both types associated with

rainstorms of low intensity and long duration. The source of runoff for the annual floods is almost entirely cultivated land. The rains are associated with warm "chinook" winds which cause rapid melting of snow. Another cause of flooding on small tributaries is cloudburst-type summer storms.

DAMAGE AREAS

Floodwater and sediment damage is more frequent and severe in the zone where the annual precipitation exceeds 16 inches. In this zone during the late winter and early spring partly frozen saturated soil produces a high rate of runoff and heavy deposition of sediment on crops, roads, ditches and other installations. Urban centers throughout the annual cropping zone are also subject to considerable floodwater and sediment damage during periods of major peak flows.

The zone with rainfall of 10 to 16 inches annually produces, as a rule, only moderate runoff because of deep soils with sufficient capacity to retain normal precipitation and because of comparatively gentle slopes. Floods that do occur are the result of heavy spring or fall rains with intensities that exceed the infiltration rates of the soil. Floodwater and sediment damages chiefly affect crop areas at the base of the hills, county roads and the areas subject to inundation along major drainageways.

The low-lying plateau area of the southwest portion of the area experiences only infrequent floodwater and sediment damage. The annual rainfall in this area is from 6 to 10 inches.

FLOODWATER AND SEDIMENT DAMAGES

The estimated average annual floodwater and sediment damages

for the Big Bend-Palouse-Lower Snake area total approximately $2,600,000 as indicated in Table V-1. These damages have been converted to long-term projected prices by multiplying the damages collected based on 1949 prices by a conversion factor.

Agricultural damages were determined on a sample stream basis and expanded to all streams in the area according to similarity of characteristics. As the Corps of Engineers had completed damage surveys along major streams and some of the minor tributaries in this area, this investigation was limited to the minor tributaries not surveyed and the watershed lands.

The streams or portions of streams in the area were classified into groups with similar damage characteristics. The classification was made by a reconnaissance survey of each stream, taking into consideration the following factors: (1) topography and watershed cover; (2) flood plain cover and types of agricultural crops subject to damage; (3) the extent of possible damage due to cultural development of the flood plain; (4) size of flood plain; (5) type of soil; (6) the extent to which irrigation facilities had been developed, and (7) the general hydrologic characteristics of the area.

Table V-1 - Estimated average annual damage
Big Bend-Palouse-Lower Snake Area
(Long-Term Projected Prices)

Type of Damage	Average Annual Damages	
Floodwater Damage		
Crops	$244,881	
Property	75,377	
Land loss	99,188	
Farm roads and bridges	14,645	
Farm irrigation and drainage	1,573	
Other agricultural	12,198	
Group irrigation and drainage	4,317	
Public roads and railroads	522,895	
Other major stream damages 1/	132,228	
Subtotal		$1,107,302
Sediment Damage		
Crops and improvements	$426,886	
Land	58,155	
Farm irrigation and drainage systems	1,923	
Farm roads and bridges	27,197	
Other agricultural	9,022	
Stock ponds and reservoirs	5,065	
Group irrigation and drainage	4,677	
Public roads and railroads	593,650	
Other major stream damages 1/	33,057	
Subtotal		1,159,632
Indirect Damages		332,763
Total		$2,599,697

1/ Damages reported by Corps of Engineers, which will remain after installation of authorized projects.

Nine sample streams or portions of streams which seemed to be most representative of groups of streams were selected for flood damage investigation. The estimated agricultural losses were obtained by interviewing farm owners and operators having land adjacent to the streams. The damage information covered losses due to particular flood occurrences over the period of the last 10 years or longer. In addition to the damages from particular occurrences the damages that occurred annually were also enumerated. The interviews covered from 20 to 50 percent of the land in these watersheds subject to overflow.

Damage values for that portion of the area included in the watershed of the Walla Walla River were obtained from the survey report completed for this watershed. 1/

Following is summarized a brief description and general characteristics of each of the sample streams:

1. Alkali Flat Creek 2/, Whitman County, Washington, tributary to Snake River below Hay:

   Watershed:
   Area: 64 square miles
   Elevation: 1500 to 2200 feet
   Av. An. Runoff: 2 inches
   Land Use: All cultivated
   Floodplain:
   Area: 1850 acres; 13 miles long
   Crops: Hay, grain and pasture; production below average because of alkali.
   Streamflow: 20 to 3200 c.f.s.

1/ Report of Survey, Walla Walla Watershed, Washington and Oregon - U. S. Department of Agriculture, January 1951.

2/ Alkali Flat Creek sample stream, due to the cover of native grass, pasture and other characteristics of the stream, was not subject to floodwater and sediment damages. However, a program to control floodwater will provide material benefits through more intensive land use.

2. Douglas Creek, Douglas County, Washington, tributary to Moses Coulee at Palisades:

Watershed:
- Area: 15 square miles
- Elevation: 2000 to 4000 feet
- Av. An. Runoff: 2.5 inches
- Land Use: 80% cultivated, 10% range, 10% forest.

Floodplain:
- Area: 340 acres; 19 miles long
- Crops: Wheat
- Streamflow: 100 to 2000 c.f.s.

3. Orondo Fan, Douglas County, Washington, tributary to Columbia River near Orondo:

Watershed:
- Area: 2 square miles
- Elevation: 800 to 3100 feet
- Av. An. Runoff: 1 inch
- Land Use: 25% cultivated, 25% forest, 50% range

Floodplain:
- Area:
- Crops: 100 acres orchard on gravel fan
- Streamflow: 20 to 9000 c.f.s.

4. Swale Creek in Klickitat County, Washington, tributary to Klickitat River above Klickitat:

Watershed:
- Area: 78 square miles
- Elevation: 1530 to 1930 feet
- Av. An. Runoff: 2 inches
- Land Use: All cultivated

Floodplain:
- Area: 1770 acres; 8.8 miles long
- Crops: grain, hay and pasture; production above average
- Streamflow: 50 to 2900 c.f.s.

5. Willow Creek, Whitman County, Washington, tributary to Palouse River near Pampa:

Watershed:
- Area: 73 square miles
- Elevation: 1300 to 2000 feet
- Av. An. Runoff: 1 inch
- Land Use: 95% cultivated, 5% range

Floodplain:
- Area: 130 acres; 5 miles long
- Crops: Grain, alfalfa, pasture
- Streamflow: 20 to 3700 c.f.s.

6. Cold Springs Creek, Umatilla County, Oregon, tributary to Columbia River near Hermiston:

Watershed:
  Area: 20 square miles
  Elevation: 1500 feet
  Av. An. Runoff: 1 inch
  Land Use: 100% cultivated
Floodplain:
  Area: 158 acres; 3 miles long
  Crops: wheat and pasture
  Streamflow: 20 to 500 c.f.s.

7. Long Creek, Grant County, Oregon, tributary to North Fork of John Day River:

Watershed:
  Area: 62 square miles
  Elevation: 3540 to 6000 feet
  Av. An. Runoff: 2 inches
  Land Use: 5% cultivated, 80% range, 15% forest
Floodplain:
  Area: 520 acres; 9 miles long
  Crops: Hay, grain and alfalfa; production average
  Streamflow: 75 to 1550 c.f.s.

8. Missouri Flat Creek, Whitman County, Washington; tributary to Palouse River at Pullman:

Watershed:
  Area: 28 square miles
  Elevation: 2340 to 3000 feet
  Av. An. Runoff: 3 inches
  Land Use: 98% cultivated, 2% forest and range
Floodplain:
  Area: 350 acres; 5 miles long
  Crops: Grain, hay, pasture and dry peas; production above average
  Streamflow: 220 to 1700 c.f.s.

9. Union Flat Creek, Whitman County, Washington, tributary to Palouse River near LaCrosse:

Watershed:
  Area: 320 square miles
  Elevation: 1400 to 4000 feet
  Av. An. Runoff: 2.5 inches
  Land Use: 90% cultivated, 8% range, 2% forest
Floodplain:
  Area: 5000 acres in 37 miles
  Crops: Hay, grain, pasture; production above average
  Streamflow: 500 to 9600 c.f.s.

Collected agricultural damages were summarized as to general types which are defined as follows:

<u>Floodwater Damage</u>

<u>Crops</u> - This includes the value of crops either partially or completely lost by floodwater.

<u>Property</u> - Included in this category are the damages by floodwater to farm buildings, including residences; to farm equipment and machinery; and the loss of livestock and the destruction of farm equipment.

<u>Land Loss</u> - The value of the land destroyed by streambank erosion, overland scouring, major gullying and entrenchment is included in this item. Minor gullying and scouring resulting in no appreciable reduction in crop yield was not included.

<u>Farm Irrigation and Drainage</u> - This covers damage caused by floodwater to farm irrigation canals, distribution systems, small privately owned diversion structures, dams, and other farm irrigation headworks.

<u>Farm Roads and Bridges</u> - Includes floodwater damage to private roads, access roads, and farm lanes.

<u>Other Agricultural</u> - This item in general covers the cost of repairing flood damages not included in the above items as well as the cost of evacuation of homes, removal of household goods and equipment, and the cost of temporary or emergency living accommodations. It also includes the cost of emergency flood prevention work, filling of gullies, etc.

Sediment Damage

Crops and Improvements - Includes the loss of crops as well as the reduction in yields due to sediment. Also included is sediment damage to buildings and equipment and clean up costs.

Land - The value of the reduction in the productive capacity of land due to deposition of infertile sand or gravel is covered by this item. The value of damage was considered to be the loss in net income due to the permanent reduction in yields. If the deposition or debris was removed the cost of removal was not included under this damage type.

Farm Irrigation and Drainage - Covers the cost of removing sediment and debris from farm irrigation diversion works, canals, and drainageways.

Farm Roads and Bridges - Includes cost of removing sediment from private roads, access roads, and farm lanes.

Other Agricultural - This type of damage covers the cost of cleanup and removal of sediment and debris from farm lands and building sites. It also includes the cost of releveling land, particularly in irrigated areas, and the cost of increased weed control.

Damages to crops and items of land destruction by stream bank erosion, scouring, entrenchment, and deposition were evaluated in terms of net income loss. Net income values were calculated on a long-term basis from typical farm budgets covering the crops grown in the area subject to damage.

The average annual damage values were determined by means of a

damage curve made by plotting damages against frequency of occurrence. Total damage for the period covered by the chart was obtained by measuring the area under the damage curve. Average annual damage was obtained by dividing this total by the number of years covered by the chart.

Other Evaluated Damages

Public Roads and Railroads - Damages to public roads and railroads were obtained by contacting the various agencies concerned and in consultation with officials of each agency, arriving at an estimated annual maintenance cost attributable to flood damage.

Group Irrigation and Drainage - Damages to organized group irrigation and drainage systems were estimated from the records of selected representative systems and the results expanded to the total land area affected.

Indirect Damages - Indirect damages were assumed to be about 30 percent of the agricultural damages, 5 percent of the public roads and railroads and 8 percent of the group irrigation and drainage damages. They include such items as loss of time, interruption and rerouting of traffic, isolation of farm residences and livestock, increased weed infestation, decline in business activities, and loss in opportunity for labor.

Intangible Damages - These are damages which have not been evaluated in monetary terms in this report, but nevertheless represent very real damages. They cover such items as loss of life, increased sense of insecurity, sickness, deterioration of fish and game habitats, and other social and aesthetic losses.

ACTIVITIES RELATED TO FLOOD CONTROL

The Congress of the United States has authorized the Department of the Army, Corps of Engineers, to construct flood control projects on segments of Walla Walla and Touchet Rivers and Mill Creek in the Walla Walla River watershed as described in House Document 578, 75th Congress, 3rd Session. The flood control works authorized consist of an off-stream reservoir, diversion and channel improvements on Mill Creek to protect the city of Walla Walla; and channel enlargement, improvement and stabilization through Milton and Freewater on the Walla Walla River, and Dayton and Waitsburg on the Touchet River. Most of this work has been completed except for the major work proposed on the Touchet River.

The proposals of the Corps of Engineers for control of flood in the watershed as described in House Document 308, 69th Congress, 1st Session and House Document 578, 75th Congress, 3rd Session, were reviewed in a survey as reported in Review Report, Columbia River and Tributaries, 1949. Further control works in selected main stream reaches were authorized by Congress in Public Law 516, 81st Congress, 2nd Session, substantially in accordance with recommendations contained in the Review Report.

The four dams authorized for installation on the Lower Snake River; Ice Harbor; Lower Monumental; Little Goose and Lower Granite; would not be significantly effective in reducing flood damages in the area as there is only a very small amount of flood plain along this section of the river and no storage capacity will be provided in these structures for flood control.

The Grand Coulee dam and the Chief Joseph dam, which is nearing completion, on the Columbia River will reduce floods on the Columbia River but the agricultural damages affected by this control are not of major significance in the area. The irrigation of about one million acres of land under the Columbia Basin Project of the Bureau of Reclamation with water provided from Lake Roosevelt may introduce new flood problems in the area as a result of the changed soil-moisture relations that will exist.

There are 30 soil conservation districts which cover approximately 75 percent of the area. They receive Federal assistance (principally technical services) from the Soil Conservation Service in farm planning and application of soil and water conservation practices and measures, many of which have value in retarding runoff and preventing erosion.

The Umatilla and St. Joe National Forests are partially in the area. Forest Service management of these areas has caused improved cover and soil conditions by improved logging methods and reductions in overgrazing on national forest lands, and by fire control on both national forest and adjacent privately owned land.

The Agricultural Stabilization and Conservation Program is making payments to land owners and operators to help defray costs of conservation measures. This is aiding in the establishment of waterflow retardation and erosion prevention measures such as improved rotations; use of green manure and cover crops; construction of terraces; waterways, and erosion control dams; and the establishment or adoption of strip cropping and contour tillage.

The Extension Service, in cooperation with the counties and states, is actively engaged in conducting educational activities to aid in the adoption and use of soil and water conserving methods of farming which will retard waterflow and prevent erosion.

RECOMMENDED PROGRAM

The program recommended is designed to meet the needs of the Big Bend-Palouse-Lower Snake area for runoff and water flow retardation and soil erosion prevention. It consists of two groups of measures, which are designed as flood prevention measures (A measures), and land treatment measures (B measures).

FLOOD PREVENTION MEASURES
(A Measures)

The flood prevention measures were developed by studying representative sample areas to determine the types and quantities of measures needed and their economic feasibility. These studies assumed that the land treatment measures would be installed at a comparable rate with the installation of the flood prevention measures in order to complete the watershed program within a period of 20 years and achieve the benefits estimated in this report.

The A measures, which are to be installed by contract or force account, are divided into five categories: floodwater retarding structures, stabilization and sediment control structures, stabilization of critical runoff and sediment producing areas, stream channel improvement, and subwatershed waterway improvement. These measures are justified largely by community and primary public benefits from reduction in damages and changes in land use that are made possible.

Flood damages can be prevented by reducing flood peaks with floodwater retarding reservoirs, by increasing channel capacities to accommodate flood flows or by a combination of these two methods. Storage possibilities, dam site conditions, damage types, downstream development, effect on downstream flood flows and relative benefits of the two types of flood control are some of the features to be considered before a method of control is adopted. Where either method is adjudged possible, the final choice depends on which shows the greater margin of benefit over cost.

Permanent materials were recommended throughout the area with vegetated channels being so classed when used as adapted and properly maintained. It is not apparent that economic changes will limit the life of the proposed structures to a degree that would indicate that temporary construction should be used. All major structures are designed to pass a 100-year flood peak with channel design capacity based on a two to ten year peak depending on estimated effectiveness of the job for damage reduction.

<u>The Recommended Program</u>

Because the flood damage prevention measures were designed for specific sample streams and expanded to like streams a description of the program for each stream will describe the area program except for quantities and location. Table V-2 identifies the samples as to character and extent of the problems involved and the conditions determining the choice of control measures.

Required structure capacities as indicated in Table V-2 vary from 1700 c.f.s. to 10,000 c.f.s. with corresponding channel design

Table V-2. - Sample stream characteristics

Sample Creek	Watershed				Flood Plain				
	Area Sq. Mi.	Runoff Inches	Elevation From - To	Main Land Use	Area Acres	Length Miles	Peak Flow c.f.s.	Crop	Production Level
Alkali Flat	64	2.0	1500 - 2200	Cult.	1850	13.0	20 - 3200	Hay-Grain	Low
Douglas	15	2.5	2000 - 4000	Cult.	340	19.0	100 - 2000	Wheat	Aver.
Orondo Fan	2	1.0	800 - 3100	Range	100	0.5	20 - 9000	Apples	Aver.
Swale	78	2.0	1500 - 1900	Cult.	1770	9.0	50 - 2900	Hay-Grain	High
Willow	73	1.0	1300 - 2000	Cult.	130	5.0	20 - 3700	Grain	Aver.
Missouri Flat	28	3.0	2340 - 4000	Cult.	350	5.0	220 - 1700	Grain	High
Union Flat	320	2.5	1400 - 4000	Cult.	5000	37.0	500 - 9600	Grain Pasture	High

capacities somewhat lower. All the streams are in relatively low elevation zones resulting in rather frequent damaging flows combined with extreme variation in peaks. Two or three high flows of one season may exceed the annual peak of another season and the extremes result when weather conditions prevent runoff until the spring thaw, thus concentrating the winter precipitation into one large and rapidly developing flow.

Stream bank erosion, land scour and silt deposition are the principal damages from such a runoff. They indicate the types of measures that might be effective and are the basis of the following sample stream programs.

Alkali Flat Creek in Whitman County traverses about 13 miles of good to poor producing flood plain, much of which is either wet or alkaline. The proposed measures consist solely of enlarging and deepening the present channel to provide drainage for the alkali areas and more rapid removal of flood waters. Extension of the drainage channels into alkali areas will be required in addition to the flood control job. This program is applied to a total of 65 miles of stream channel largely located in the Ritzville-Connell area.

Douglas Creek in Douglas County, and Missouri Flat Creek in Whitman County, are similar in problems and program so they are grouped together. Watersheds of both are devoted largely to wheat production with fertile flood plains where silt has gathered for years from the surrounding hills. These flood plains are generally too wet for grain and too frequently flooded to plow, so a wet pasture culture has developed.

The proposed program is for straightening, deepening and clearing channels to provide capacities for two-year frequency peaks, with stabilizing structures as required to prevent the straightened channels from cutting deeper. Multiple purpose reservoirs could well be made a part of the development in either watershed and similar watersheds and should be investigated before project plans are developed.

The Orondo Fan in the west side of Douglas County is an example of a debris basin to protect orchard-planted fan areas from cloudburst storms. It has a 20-acre diked basin designed to hold the coarse material moved out of the canyon by heavy storms and to provide temporary storage for the water until it can be safely carried to the outlet drainage. The design storm of 100-year occurrence is 9,000 c.f.s. for which channel capacity should be provided.

This type of program is confined to the breaks of the Columbia River not because the cloudburst storms are limited to these areas, but because the development of orchards on the fans makes a high damage potential not found in other parts of the area.

Lower Union Flat Creek in south Whitman County and Swale Creek in Klickitat County are similar in many respects. Both are low gradient streams draining highly cultivated watersheds. The problem of late wetness is common to both although bank erosion is more prevalent on Union Flat.

Their recommended program consists of increasing the channel capacities to provide more rapid disposal of spring flood waters

and an outlet for drainage. Some drainage benefits will result from the program without additional channels.

Willow Creek near Pampa in Whitman County was selected as a sample of program development to combat an advancing gully. It is similar to, but less severe than, Dry Creek in Walla Walla County and the remedy for both consists of drop structures to prevent further development. Retention of silt above the structures provides an opportunity to rebuild some of the lost land.

In addition to Dry Creek in the Walla Walla watershed, flood prevention programs were proposed for thirteen small watersheds which included twelve floodwater retarding reservoirs. These differ from other programs in the area only by the inclusion of the floodwater retarding reservoirs. Capacities of these basins vary from 200 to 1700 acre feet. With the exception of the one in Woodward Canyon it is proposed that they be provided with gates, making possible the storage of water for irrigation after the flood season is over.

Wilson Creek in Lincoln County provides a sample of control by means of reservoir construction having other uses that provide greater benefits than the flood prevention function. The greatest benefit to be derived from such a reservoir is the use of the stored water for irrigation. Sixty of these are listed for further investigation because time did not permit further study at the time the survey was made. Irrigation needs, with occasional damaging floods in such confined areas as the Crab Creek and Lind Coulees indicate a need for multiple purpose structures. They would also become

feasible programs in the Palouse, Walla Walla and Pataha watersheds when erosion is controlled on cultivated lands above reservoir sites.

All of the proposed measures for flood damage prevention are grouped under five headings, some of which include many types of work and materials.

The construction of 22 floodwater retarding structures is proposed for the Walla Walla watershed and most of them have additional benefit, as conservation storage for irrigation use.

Stabilization & Sediment Control Structures

Thirty-four stabilization and sediment control structures are proposed near the mouths of tributaries entering the Columbia River. Most of these structures will serve as debris collectors to prevent damage to orchard lands on and near the fans built up at the canyon openings. Either a state or county highway crosses most of the fan areas included in the program.

Stabilization of Critical Runoff and Sediment Producing Areas

Practices for erosion control on critical areas include measures needed for erosion and drainage control on roads and trails, stabilization of slips and slides and severe sheet erosion control. Roadside and trail erosion control is needed along 538 miles of rights-of-way throughout the watershed. Because the topography is rolling, road construction has necessitated making cuts with rather steep banks that are left bare and unprotected. The borrow pits, in many cases, are on grades that erode badly.

The practices to stabilize slips, slides and gullies are needed on about 85 acres in the steeper areas in the eastern part of the

watershed in Whitman, Garfield and Columbus Counties. Sheet erosion control practices are needed on public lands that are denuded of vegetation and are sources of accelerated runoff and sediment. The total area to be treated is 5,120 acres.

Stream Channel Improvement

Tributary channel improvements include clearing, enlarging, realigning, riprapping, vegetating, revetment and cleaning of debris. All are included as needed in the 505 miles of channel improvement proposed.

Included in the channel improvement, are the 395 waterway stabilization structures proposed. They are required to prevent deepening of watercourses into unmanageable gullies. They will also reclaim, by sediment deposition, some of the gullies now formed.

Subwatershed Waterway Improvement

About 12 miles of subwatershed waterway improvement is required.

LAND TREATMENT MEASURES
(B Measures)

The land treatment measures included are those used for the conservation of water and watershed lands which contribute directly to flood prevention. Benefits are primarily at the site of installation with direct and substantial contribution to the achievement of the objective of the Flood Prevention Program. They can be installed by individual operators using their labor and facilities with technical assistance by the Federal Government.

The land treatment measures were determined by several methods. The quantities of measures needed on private crop and range land were determined on a county basis by committees representing various

USDA agencies. The county needs were consolidated to arrive at the total amounts needed for the area. Only those measures applied to sloping land that had appreciable value for watershed protection are included in the flood prevention program. This selection involved omission of measures on flood plain irrigated land and those on sloping land that are designed exclusively for increased production.

Program measures for state-owned lands were developed essentially by state foresters and other state officials. The program for national forest lands was built up largely from a field inventory made by each district forest ranger with direct assistance from regional technicians. To obtain parallel program material for other public lands, meetings were then held with other land managing agencies, including the Indian Service, National Park Service, Bureau of Land Management, Fish and Wildlife Service, and several state forestry divisions. After the total program was developed, technicians of the Forest Service selected those measures and percentages of total program measures that would serve in aid of flood prevention as well as maintain the range and timber resource and increase production.

The land treatment practices and measures recommended in the Big Bend-Palouse-Lower Snake area as a part of the flood prevention program are described below.

Cropland

Contour farming is needed on approximately 1,668,900 acres and contour strips on 1,122,500 acres in this area. This is farming

slopes whereby plowing, planting, cultivating, and harvest operations in the production of field crops, and in orchards and vineyards, follow lines that are level or conform to accepted standards for grade. Farming operations usually are parallel to terraces, field diversions, contour strip cropping boundaries, contour planted trees or vinerows or temporary guide lines. Contour strip cropping, contour planting and all other cultivation operations performed on the contour to hold surplus water or dispose of it at non-erosive velocities are considered forms of contour farming. Practices of this type are required if cultivated crop production is to be maintained on a large part of the undulating and sloping lands. These practices will aid materially in reducing runoff and stabilizing the topsoil.

Terraces Approximately 450 miles of terraces are recommended for construction on sloping and undulating cropland. The major portion are needed in Garfield County, Washington. Terraces are graded channels across the slope to intercept and control runoff and minimize erosion. The channels are constructed with supporting ridges on the lower sides and are laid out in a manner to permit them to be cultivated with the field. Gradient terraces, which will dispose of surplus water at non-erosive velocities are needed on impervious soils and level terraces which will hold available moisture on the land are needed on the permeable soils. Terraces of proper design divide long slopes catching the water before it accumulates into damaging amounts. They encourage contour farming, and in general, maintain and increase crop yields. They are adapted

for use on long slopes of less than 10 percent in the dry farming areas. Sodded waterways and protected terrace outlets are essential to a well designed terrace system.

Field diversions Approximately 1,200 miles of field diversions are needed on the cropland in the area. The major portions of these are needed in Walla Walla, Columbia, Whitman and Garfield counties in Washington and Latah County in Idaho. They are graded channels across the slope, to intercept runoff water from upper areas or at regular intervals across cultivated areas. These channels are constructed with supporting ridges on the lower side and are not cultivated with the field. They are usually protected by vegetation. Field diversions are often used to divert the excess water from the relatively steep rangeland before it has a chance to sweep down across the cropland. They are also used on slopes that are too steep for terraces and as temporary protection for drainage areas while sodded waterways are being established.

Vegetated Waterways There are approximately 18,000 miles of vegetated channels needed. This measure includes shaping the channels and planting them to permanent vegetative cover. They are required largely on grain lands.

Crop residue utilization is needed on approximately 2,940,000 acres. This is utilizing vegetative materials on orchards, vineyards and croplands, such as straw, stubble, prunings, and other crop residues, in such a manner as to reduce wind and water erosion, conserve moisture and improve the soil. It includes mixing the materials into the soil or leaving them wholly or partially on the surface.

Subsoiling is needed on approximately 407,400 acres of the cropland. Most of the land that requires subsoiling is in Lincoln, Adams, Garfield, Franklin, Grant, Douglas and Walla Walla counties in Washington and Latah county in Idaho. This practice is tilling the soil at least 18 inches deep to break up the plow sole, heavy clay subsoil, or a calcareous layer which often forms in the subsoils of arid regions. This practice can be used to good advantage periodically on those soils that have a tight layer, not more than three feet below the ground surface, which restricts the passage of water and roots into the subsoil.

Cover cropping Cover crops are needed for the protection of approximately 844,200 acres of the cropland. This practice is planting annuals and biennials primarily to provide cover for erosion prevention on sloping land.

Conversion seeding and planting is needed on approximately 213,100 acres of Land Use Capability Classes VI and VII land to effect a permanent change to more efficient land use. This is cropland which because of steep slopes, drouthiness, shallow depth, boulders, or subject to severe wind erosion, should not be cultivated. It should be seeded down to adapted grasses and legumes or planted to trees and kept permanently in pasture or woodland.

a. The seeding of perennial grasses and legumes is recommended for approximately 205,100 acres. (The cost of this item is carried as reseeding in the range program).

b. The planting of forest trees is recommended for 8,000 acres on the higher elevation and hill tops in the eastern part of the

Palouse River watershed (Included in item for tree planting on forest land).

Rotation seeding The seeding of perennial grasses and legumes in a desirable crop rotation system is needed on approximately 1,060,500 acres of cropland. This does not include the annual and biennial grasses and legumes used for green manure and cover crops. Rotation seedings are effective in building up soil fertility and soil structure and counteracting the losses from soil-depleting crops. The legumes help to replenish the nitrogen and the grass and legume roots replace much of the organic matter which is broken down and used in the production of annual crops. Deep rooted legumes and grasses also bring to the surface plant food otherwise unavailable to shallow rooted crops.

Pasture seedings are recommended for approximately 240,000 acres. This practice is the establishment of forage plants for pasture, by seeding, sprigging or other methods. These are permanent pastures to be kept in as long as they are productive. When plowed out, this land will be farmed for one or two years to control weeds and undesirable species and then be reestablished to pasture.

Pasture management is needed on approximately 466,000 acres. This is maintaining a protective cover of vegetation in a manner which will increase forage, check erosion, restore or increase soil fertility and improve soil moisture conditions. It includes rotation grazing, proper stocking, fertilization, plant residue accumulation, the mowing of pastures, the scattering of droppings and in irrigated sections the correlation of irrigation with other activities.

Fertilizing Fertilizing to establish soil conserving crops is needed on about 40,400 acres. The major fertilizer elements needed for that purpose are nitrogen and phosphorus.

Rangeland

Seeding and Planting It is recommended that about 520,000 acres be seeded or planted to grasses, herbaceous plants or shrubs. This practice includes the establishment of protective cover where natural revegetation will not restore cover within a reasonable period of time or where unpalatable weeds and shrubs predominate. It does not include the seeding and planting of gullies and critical erosion sites.

Fertilizing It is recommended that 340,000 of the acres recommended for seeding and planting be fertilized (about 20 pounds of nitrogen per acre) to assist in the establishment of a vigorous and productive stand. The range lands in the lower condition classes which are recommended for seeding and planting are low in nitrogen and organic matter.

Fences It is recommended that about 1,522 miles of cross and drift and protective fencing be constructed for the proper control and distribution of livestock and to protect new seedings on range lands until the plants become established. This practice does not include fencing for pasture management or boundary fences. In order to set up a system of rotated, deferred grazing, to separate pastures of different seasonal uses, and to facilitate the handling of livestock on the range, internal fencing is necessary in all of the counties in this area. Fencing ties in directly with the livestock management practices.

Driveways and driftways It is recommended that about 110 miles of driveways and driftways be provided.

The construction of driveways are sometimes necessary to eliminate livestock travel from roads or to provide definite routes for livestock travel between roads and distant range allotments or areas. The construction of stock trails through rock, timber or other natural barriers can aid in obtaining better distribution of livestock and better utilization of forage or water.

Water developments It is recommended that approximately 2,655 additional water developments be constructed to provide livestock water. This practice includes the construction of livestock watering ponds, tanks, small reservoirs, springs or seeps and stockwater wells. Water storage facilities such as ponds, tanks and small reservoirs are most applicable under conditions where there is no natural gravity water and/or the difficulty and expense of drilling a well are prohibitive.

Water spreading and irrigation Water spreading and irrigation is recommended for about 7,300 acres. Under this practice are included the construction of facilities to divert runoff water from watercourses or gullies and to distribute it through systems, not requiring manual operation, onto adjacent grazing lands; and the irrigation of non arable lands having high forage producing capabilities.

Rodent control is needed to reduce populations of jackrabbits, porcupines, ground squirrels, gophers and mice. These animals in

many instances are causing considerable damage to range and timber, and preventing the establishment of new stands. This practice is needed on about 82,000 acres of range and forest land.

Proper stocking This practice is recommended for about 1,562,400 acres. This management practice is the grazing of land at such intensity as will make proper use of available forage. Proper use rates will leave sufficient vegetation to control erosion.

Deferred grazing Deferred grazing is recommended on about 670,640 acres.

Deferred grazing is the postponement of grazing through the growing and seed development period of the more important plants to permit seed production, seedling establishment, the recovery of the forage plants.

Fire control improvements This practice includes the construction of lookout towers, clearing of firebreaks, snag felling, disposal of slash and debris, and other work needed to reduce fire hazards and increase the efficiency of the fire protection organization. Cost of the various measures which have flood prevention benefits amounts to $59,072.

Forest Land

Planting forest trees This includes the establishment or reestablishment of a forest cover for timber production and watershed protection purposes, either by direct seeding or by planting nursery stock, and applies both to reforestation of non-stocked areas and to interplanting thin stands to attain full protective use and productive capacity of the site. Needs are for 27,460 acres.

Revegetation of woody shrubs This measure is required on about 10,400 acres. It is primarily to provide food and cover for wildlife but has a secondary flood prevention benefit as a result of stabilizing the types of lands for which it is recommended.

Cooperative fire control This includes fire control on non Federal lands by Federal cooperation with states. The estimated cost of this measure is about $78,000. This item includes equipment, construction of towers, buildings and other facilities for effecting a fire control program on Federal lands. It also includes clearing of fire breaks, snag felling, disposal of slash and debris, and other work needed to reduce fire hazards and increase the efficiency of the fire protection organization. The cost of this measure is estimated at about $614,000.

Technical services and plans are needed in applying the above measures to about 4,713,500 acres of crop, range, and forest land. These services are to be provided by Federal and state agencies.

COST OF RECOMMENDED PROGRAM

The estimated cost of installing both the flood prevention ("A") measures and the land treatment ("B") measures is $56,361,239 based on projected long-term prices (see tables V-3 and V-4). It is estimated that local interests will provide about 82 percent of the cost of installing these measures; however, the allocation of Federal and non Federal costs will vary by types of measures. The cost of land treatment measures on privately owned land will generally be borne entirely by individual landowners and operators except for technical assistance since most of the benefit will accrue

directly to the land on which the measures are applied. Flood prevention measures, on the other hand, produce public benefits often of a dispersed nature, and extending far downstream. The Federal government will install these measures on a cost-sharing basis. The cost of installing, operating and maintaining the measures on Federal land will be borne by the agencies responsible for the administration of such land.

Total average annual costs of the program are estimated at $13,646,242. This was arrived at by amortizing public installation costs at 2 1/2 percent interest and private at 4 percent over a 50-year period, plus estimated annual operation and maintenance costs. In the case of recurring measures, the initial once over costs were amortized as an installation cost and the recurring costs were treated as average annual operation and maintenance.

Approximately $12,926,579 or over 95 percent of the total average annual costs are expected to be borne by local interests.[1/] The annual cost to the Federal government will be about $719,663, of which $95,400 will be on Federal land.

Flood Prevention Measures (A Measures)

The estimated cost of installing the flood prevention measures is $6,379,208 (Table V-3). Of this cost, it is estimated that the Federal government will expend $361,607 on Federal land and $4,488,483 on non Federal land. Local interests will expend about $1,529,118 on non Federal land.

Local interests will be required to furnish without cost to

1/ Does not take into account any ASC payments.

Table V-3. - Estimated cost of installing flood prevention measures
(A Measures)
Big Bend-Palouse-Lower Snake Area
(Long-Term Projected Prices)

Measures	Unit	Quantity	Costs Federal	Non-Federal	Total
			dollars	dollars	dollars
Floodwater Retarding Structures					
Non-Federal land	Each	22	1,602,668	534,222	2,136,890
Stabilization & Sediment Control Structures					
Federal land	Each	21	74,760		74,760
Non-Federal land	Each	13	204,255	68,085	272,340
Stream Channel Improvement					
Tributary Channels					
Federal land	Miles	15	26,700		26,700
Non-Federal land	Miles	490	1,471,170	490,390	1,961,560
Stabilization Structures					
Non-Federal land	Each	395	1,044,638	348,212	1,392,850
Stabilization Critical Runoff and Sediment Producing Areas					
Sheet Erosion Control					
Federal land	Acres	2,900	129,940		129,940
Non-Federal land	Acres	2,220	72,691	24,230	96,921
Slide Stabilization					
Federal land	Acres	11	45,746		45,746
Non-Federal land	Acres	74	31,840	10,613	42,453
Road Erosion Control					
Federal land	Miles	240	80,634		80,634
Non-Federal land	Miles	298	49,440	49,439	98,879
Subwatershed Waterway Improvement					
Federal land	Miles	2	3,827		3,827
Non-Federal land	Miles	10.3	11,781	3,927	15,708
Subtotal Federal land			361,607		361,607
Subtotal Non-Federal land			4,488,483	1,529,118	6,017,601
Total			4,850,090	1,529,118	6,379,208

the Federal government all land, easements, and rights-of-way needed in connection with the installation of the flood prevention measures; and will be expected to make any additional contributions that may be necessary to meet their proportionate share of the cost of installing these measures as determined by the Secretary of Agriculture to be equitable in consideration of the anticipated benefits from such measures.

The total estimated average annual cost of the "A" measure program is $337,045.

Based on the anticipated source of funds for installation and operation and maintenance costs in accordance with the nature of the measure and the ownership of land on which installed, about 53 percent, or $178,863 will be expended by the Federal government. Of this latter amount, $20,600 is on Federal land.

Land Treatment Measures (B Measures)

The estimated cost of installing the land treatment measures is $49,982,031 (Table V-4). Of this cost, it is estimated that the Federal government will expend $1,157,862 on Federal land and $4,323,221 on non Federal land, and that local interests will expend $44,500,948 on non Federal land. The estimated Federal cost of these measures on non Federal land does not include financial assistance by the Federal government such as Agricultural Stabilization and Conservation Program payments to landowners and operators. Any assistance of this kind that may be provided at the time of program installation will help landowners and operators in installing the program.

Table V-4. - Estimated cost of installing land treatment measures
Big Bend-Palouse-Lower Snake Area
(Long-Term Projected Prices)

Measures	Unit	Quantity	Costs		
			Federal	Non-Federal	Total
			dollars	dollars	dollars
Cropland					
Contour Stripping and Planting	Acres	1,122,500		1,013,596	1,013,596
Terracing	Miles	450		39,044	39,044
Field Diversions	"	1,200		204,164	204,164
Vegetated Waterways	"	18,000		1,990,470	1,990,470
Contour Farming	Acres	1,688,900		358,792	358,792
Crop Residue Utilization	"	2,939,250		7,583,650	7,583,650
Subsoiling	"	407,355		2,905,940	2,905,940
Cover Cropping	"	844,200		7,260,120	7,260,120
Rotation Hay & Pasture Seeding	"	1,060,490		10,944,360	10,944,360
Pasture Seeding	"	240,000		3,096,516	3,096,516
Pasture Management	"	465,900		1,202,151	1,202,151
Fertilizing-Est. Cons. Crops	"	40,410		417,134	417,134
Rangeland					
Range Improvement					
Seeding Grasses and Herbs					
Federal land	Acres	9,500	72,283		72,283
Non-Federal land	"	510,500		3,472,473	3,472,473
Fertilizing					
Federal land	Acres	375	6,450		6,450
Non-Federal land	"	339,800		1,463,720	1,463,720
Water Spreading & Irrigation					
Federal land	Acres	3,300	70,950		70,950
Non-Federal land	"	4,000		27,520	27,520
Stockwater Facilities					
Federal land	Each	19	7,504		7,504
Non-Federal land	"	2,636		778,472	778,472
Fencing					
Federal land	Miles	121.5	93,422		93,422
Non-Federal land	"	1,400.5		757,308	757,308
Driveways and Driftways					
Federal land	Miles	9.5	2,425		2,425
Non-Federal land	"	101		33,626	33,626
Misc. Stock Handling Facilities					
Federal land	Each	26	16,942		16,942
Non-Federal land	"	27		17,415	17,415
Rodent Control					
Federal land	Acres	31,770	24,175		24,175
Non-Federal land	"	50,190		21,581	21,581
Stream Improvement					
Federal land	Miles	2.7	1,389		1,389
Non-Federal land	"	4.7		2,399	2,399

Table V-4 (cont'd.) - Estimated cost of installing land treatment measures
Big Bend-Palouse-Lower Snake Area
(Long-Term Projected Prices)

Measures	Unit	Quantity	Costs Federal	Non-Federal	Total
			dollars	dollars	dollars
Range Management					
Proper Stocking	Acres	1,562,400		67,183	67,183
Deferred Grazing	"	670,640		57,654	57,654
Fire Protection	"	2,289,600		59,072	59,072
Forest Land					
Tree Planting					
Federal Land	Acres	3,660	109,908		109,908
Non-Federal Land	"	23,800	35,943	682,907	718,850
Revegetation of Woody Shrubs					
Federal Land	Acres	10,030	125,904		125,904
Non-Federal Land	"	400		1,737	1,737
Cooperative Fire Control			38,978	38,977	77,955
Fire Control - Federal Lands			613,670		613,670
Technical Services (Crop)			2,772,600		1,269,102
Technical Services (Range)			1,475,700		2,384,436
Plan Preparation					
Federal Land			12,840		12,840
Non-Federal Land				2,967	2,967
Subtotal Federal Land			1,157,862		1,157,862
Subtotal Non-Federal Land			4,323,221	44,500,948	48,824,169
Total			5,481,083	44,500,948	49,982,031

The estimated total annual cost of these measures is $13,078,987. Of this amount the Federal government will expend $74,800 on Federal land and $275,386 on non Federal land, including $110,000 for annual cost of accelerated educational assistance, and local interests will expend $12,728,801 on non Federal land.

BENEFIT FROM THE RECOMMENDED PROGRAM

The estimated benefits to be obtained from the reduction of floodwater and sediment damages by the installation of the proposed program were obtained by two separate evaluations. First, the benefits from reduction of floodwater and sediment damages which would result from the application of the land treatment practices and measures (B Measures) were determined. Second, the benefits of the flood prevention measures (A Measures) were evaluated on the basis of their effectiveness in reducing floodwater and sediment damages remaining after the benefits of the land treatment program had been taken into consideration.

HYDROLOGIC EVALUATION OF LAND TREATMENT PROGRAM (B Measures)

As indicated earlier in this report, flood problems arise from two distinct and separate types of meteorologic events: winter and spring rains, often combined with snow melt, on saturated or frozen soils, and summer convection storms. The former result from cyclonic storms which move in from the Pacific Ocean, generally last a few days, and affect large areas. The latter are violent in nature, result from local atmospheric conditions, cover very small areas, and last from several minutes to a very few hours. Runoff from these two types of storms is controlled by two separate phenomena, the

transmission or percolation capacity of the soil profile in the case of winter storms, and the surface intake infiltration capacity of the soil surface in the case of summer storms.

These fundamental differences in runoff causative factors materially affect the results that may be expected from good land treatment in reducing runoff from the two types of storms. To be effective in reducing runoff from winter storms, land treatment must be such that it opens up, and keeps open, the restrictive strata in the soil profile during periods of soil saturation and/or freezing. To reduce runoff from intense summer storms, land treatment must protect the soil surface from the sealing effect of rain drop bombardment. Both types of land treatment may reduce the bulking of runoff, but not runoff water itself, by reducing erosion and thus the bulking effect of high sediment concentrations in the runoff water. This bulking may reach such high amounts as 20 percent and commonly may be equivalent to two to five percent by weight.

Characteristically, floods on the larger streams in this area are caused by large cyclonic storms in winter or early spring, which cause high total precipitation on saturated or frozen soils, rapid melting of snow on saturated or frozen soil, or combinations of rainfall from cyclonic storms and snow melt. Floods in this area are commonly associated with "chinooks", defined here as warm winds from the south and west.

Floods on small streams in this area are associated with conditions cited in the preceding paragraph, and with the violent

convection storms, locally called "cloudbursts" or "waterspouts", in the spring and summer. These convection storms do not cover large enough areas to cause serious flooding on large streams.

No applicable research data are available to indicate the effects of land treatment on runoff and floods on watersheds larger than a few acres in the area. A limited amount of data on small watersheds are available from the Palouse Experiment Station at Pullman, Washington; from short-time studies on two small watersheds at Moscow, Idaho; and one at Dayton, Washington. To estimate the effects of land treatment, therefore, in the absence of applicable data, an indirect approach was necessary. Two independent approaches were followed; (1) a statistical approach, and (2) a rational approach.

Cyclonic Storm Flood Evaluation

Statistical Estimates

To develop a hydrologic base for evaluating the effectiveness of forest land treatment in reducing flood runoff, multiple correlation and regression analyses were made to determine the relation of peak discharges to meteorological and watershed characteristics.

The problem to which the method of correlation analysis was applied concerned an estimate of the effect of each of the flood causes or associated factors (independent variable) upon peak discharge (dependent variable). Essentially, the problem involved a determination of the manner in which available data obtained from different sources and pertaining to several major factors affecting peak discharge could be used to yield the best estimate of probably peak discharges.

Existing hydrologic data were compiled to develop indices of the major sources of variation in flood size. Rainfall and temperature data are collected by the U. S. Weather Bureau in cooperation with numerous public and private agencies. These data are available in Weather Bureau publications such as hydrologic bulletins and climatological data reports. Records of stream flow and peak discharges are made by the U. S. Geological Survey. These records are available in publications of the Water Resource Branch of the U. S. Geological Survey. Other pertinent physical data were obtained from maps and charts of the War Department, records of the Forest Field Survey and Geological Survey and aerial photographs.

The separate effect of each index was isolated sufficiently to permit an estimation of the forest cover effect. The results are summarized in the following equations. (The variables were subjected to logarithmic transformation to permit the proper expression of any exponential relationships.)

(1) $$\log Q'8 = 5.0733 + .2874 \log FR + .5845 \log WR - .8900 \log WT + .1357 \log SR - .2660 \log ST - .8061 \log n\text{-}s - 2.2607 \log PH - .9336 \log DA,$$ where

Q'8 = peak discharge as computed with 8 variables.
FR = fall rain (October) - inches.
WR = winter rain (November - March) - inches.
WT = winter temperature (November - March) - mean temp. $^{\circ}$F
SR = spring rain (April - flood date) - inches.
ST = spring temperature (April - flood date) - mean temp. $^{\circ}$F
N-S = component of watershed slope - percent.
PH = a watershed physiographic index - percent.
DA = watershed drainage area - square miles.

The fall precipitation provides an index of ground water conditions. Precipitation during the winter is an index of moisture

accumulated in the snow pack for release upon melting. The amount of moisture accumulated is affected by losses from the snow pack through melting and sublimation - temperatures during the accumulation period affect losses from the snow cover, and therefore affect flood runoff. Temperature and precipitation near the end of the nominal snow season deserve special consideration. Basin characteristics affecting the variation in magnitude of floods between watersheds consist of the drainage area, the NS slope and exposure, and a physiographic index which serves as an important factor in relation both to drainage composition and physiographic development of the drainage system.

Other indices could be used in addition to or in lieu of those developed. For example, fall stream flow might be used as an index to soil moisture. Also, if snow survey records of sufficient length and reliability were available, the water content of the snow might be used as an index of moisture available for release upon melting. Although there are many possible combinations of flood-causing factors which may be used, the problem is much the same, consisting essentially of a determination of the way in which several factors act together in their influence on flood magnitude. Of first concern is the selection of those major factors, for which records are available for a particular area, and the utilization of those records in a manner which will give significant results.

Peak discharges were computed using equation (1). These values were then used as a variable with the total area in square miles

of poorly stocked and burned forest land (PSB) to develop the following equation. (2) $Q'9 = 1.0681 \log Q'8 + .0450 \log PSB$.

By analysis of variance and "t" tests all variables were significant in their effects on flood peak discharge. The multiple correlation coefficient of equation (2) is .9006; and the standard error is .2320 (log units). This degree of correlation results from the fact that a great range of values have been considered in the analysis, and the degree of accuracy of the equation should be as near as the basic data will permit.

Program Effects on Peak Discharges

Estimates of flood reductions were based on differences between peak discharge under the present trend of land use and under the future, the latter representing watershed improvements achieved under the recommended land treatment program.

The forest measures have as their objective the maintenance of an optimum cover density to offset the loss of the old stand effect on runoff. This is to be accomplished by an intensified fire protection program, the planting of non-restocked areas and a general improvement in silviculture practices.

The effectiveness of the forest remedial program in reducing peak discharge was analyzed for 21 sample watersheds for which hydrologic data were available. The average densities of the 21 watersheds with and without a program were expressed in areas non-stocked and burned. These values were substituted into equation (2). The results showed that the average watershed with 65 percent forest area would have peak discharges reduced by 10 percent with a

forest program effective. This relation was then used to estimate the reduction on the sample watersheds for which damage discharge curves have been made. Table V-5 shows the estimated peak reduction contributed by the forest program.

To estimate the effect of improved range land on discharges it was necessary to make indirect estimation by using infiltrtion indices. The influence of cover condition on infiltration capacity is indicated by FA infiltrometer studies made for the Walla Walla flood control survey report. These rela tive infiltration determinations and interpolations are indicative of the changes in the hydrologic characteristics of the soil under different cover conditions. Using the direct determination of the effects of forest cover density changes on discharges as indicated by regression analysis, the range condition classes were converted to hydrologic equivalents in terms of cover densities by using the infiltration measurements as indices. The following steps were taken.

1. The infiltration capacities as determined by the infiltrometer runs were multiplied by 0.3 to be in line with absolute values that would prevail under natural precipitation conditions, and to allow for soil and channel storage. 1/

1/ From "A Method of Hydrologic Analysis in Watershed Management" P. B. Rowe, Trans. Amer. Geophys. Union, Pt. II, pp. 632 - 49.

2. Maximum hourly rainfall rates on forest and range lands for a four-hour design storm of several frequencies were estimated. These were based on precipitation records in and near the Walla Walla watershed.

3. Precipitation excesses over infiltration, for the cover conditions and for the various sizes of storms, were obtained by subtracting the adjusted infiltration indices from the rainfall rates.

Assuming that precipitation excess is an index of relative runoff producing potential, we can with reference to the forest, estimate in terms of cover density the effectiveness of good, fair and poor range treatment on runoff. Expressing this effectiveness in terms of equivalent forest cover density permits an estimate of the effects on peak discharges of changing a given area from one degree of use to another.

Carrying out similar calculations for ranges as on forest densities, the average reduction on a watershed with 65 percent range land was found to be 5 percent. This relation was then used to estimate peak reductions on sample watersheds for which discharge-damage curves were made. These are shown in Table V-5.

In preparing Table V-5 the land treatment measures on cropland were estimated as causing an average peak reduction of 10 percent on a watershed with 100 percent cropland.

Table V-5.--Estimated peak discharge reductions on sample watersheds as a result of proposed land treatment program

Sample Watershed	Due to Forest Program	Due to Range Program	Due to Cropland Program	Total Estimated Reduction
	percent	percent	percent	percent
Chumstick Creek	16.0	-	-	16.0
Orondo Fan	3.8	3.8	2.5	10.1
Wilson Creek	5.0	4.0	1.0	10.0
Douglas Creek	1.5	0.8	8.0	10.3
Swale Creek	-	-	10.0	10.0
Missouri Flat Creek	-	-	10.0	10.0
Union Flat Creek	0.3	0.6	9.0	9.9
Tucannon Creek	14.0	1.0	-	15.0
Average reduction				11.4

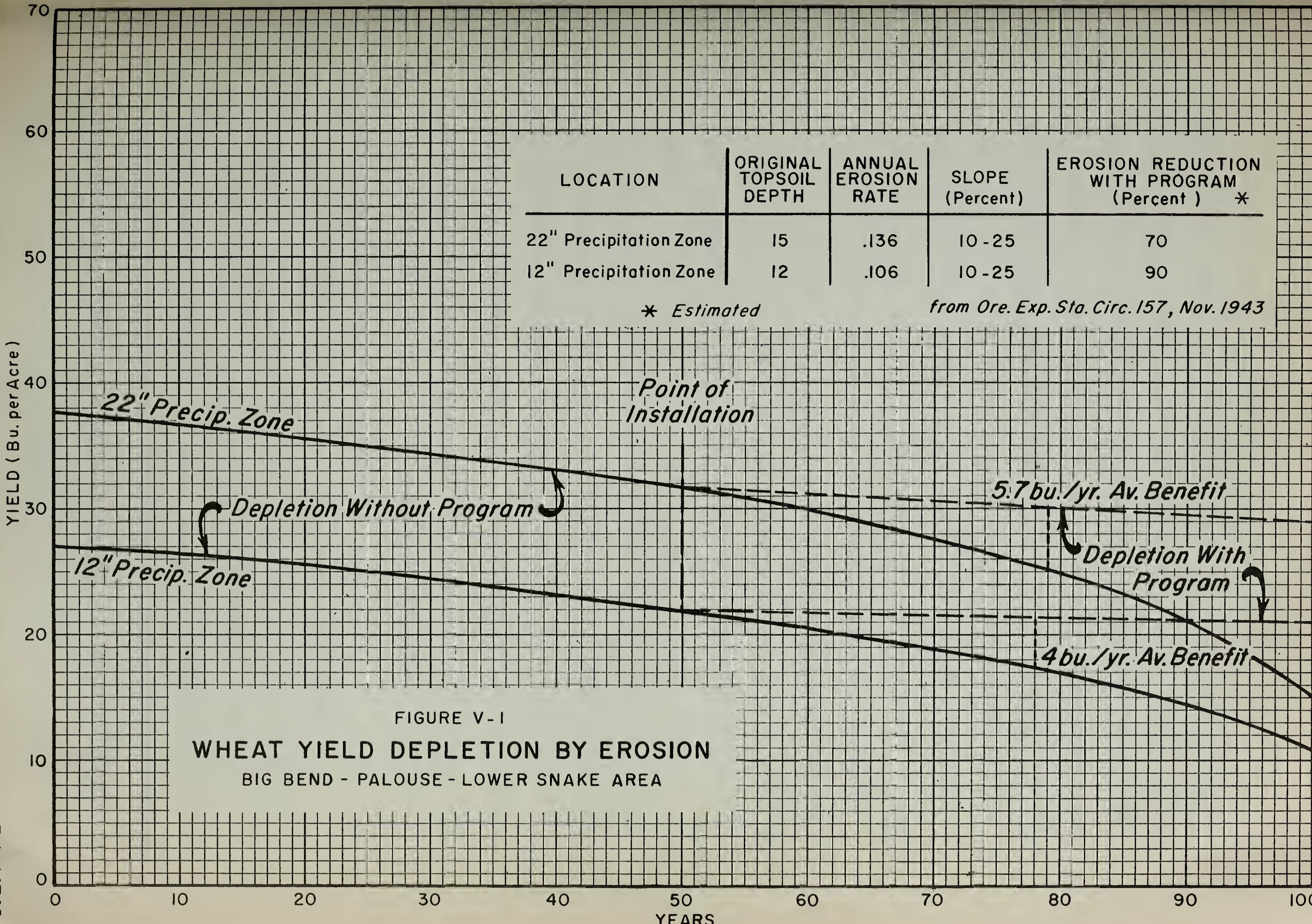
EVALUATION OF LAND TREATMENT PROGRAM
(B - Measures)

Cropland

Effectiveness of the land treatment measures is indicated in a number of ways. Since erosion causes depletion of soil fertility and reduces its arability the control of erosion will assist in maintaining productive capacity and preserving a soil condition conducive to ease of cultivation. Sediment resulting from erosion is a major cause of crop loss in locations vulnerable to deposition. Sediment deposits kill growing grain crops at a time or in such locations that reseeding is not feasible. Added to the crop damage is an annual deposit of sediment on county roads of the eastern part of the area. This particular item of damage could be largely eliminated by application of the land treatment measures.

Erosion depletion on land capability classes IIIe and IVe has been great enough to make cultivation of much of the area so classified, a marginal operation for wheat production. Average production is maintained by increases on the bottoms and other less erodible areas.

The chart, Figure V-1 illustrates depletion rates in the 12" and 22" rainfall zones of the Oregon wheat growing area. Counteraction of this depletion of topsoil is the principle benefit of the land treatment program. Its effect on wheat yields is illustrated by this chart based on Oregon agricultural experiment station data from the Wildhorse and Rock Creek watersheds.



LOCATION	ORIGINAL TOPSOIL DEPTH	ANNUAL EROSION RATE	SLOPE (Percent)	EROSION REDUCTION WITH PROGRAM (Percent) *
22" Precipitation Zone	15	.136	10-25	70
12" Precipitation Zone	12	.106	10-25	90

* *Estimated*

from Ore. Exp. Sta. Circ. 157, Nov. 1943

FIGURE V-1

WHEAT YIELD DEPLETION BY EROSION

BIG BEND - PALOUSE - LOWER SNAKE AREA

Average annual benefit per acre from the land treatment measures in terms of wheat production is 5.7 bushels in the annual cropping zone (average precipitation - 22") and 4.0 bushels in the wheat-fallow zone (12" precipitation). Applying this benefit to the affected acreage of wheat grown in the respective zones gives for the 22" zone 4,560,000 bushels, and 4,000,000 bushels for the 12" zone, or a total annual benefit of 8,560,000 bushels for the entire area wheat lands. It was assumed that half the affected land of the 12" zone was cropped each year and two-thirds of that in the 22" precipitation zone, when calculating yield benefits.

Soil depletion rates are somewhat higher in eastern Whitman County than in any other part of the area but the more conservative rates determined by the Wildhorse watershed investigation were assumed to have a wider areal application.

Corollary to the prevention of soil depletion is a reduction of sediment and flood peaks accomplished by the measures applied to cropland. Sediment reduction varies from 50 to 100 percent depending on weather conditions. Extreme variations of temperature combined with intense precipitation provide the highest loss but an average reduction of 70 percent is obtainable throughout the area where erosion is a problem.

This reduction of sediment production is reflected in a reduced crop loss, both at the base of slopes and on floodplain cropland. It also effects considerable reduction in the maintenance cost of irrigation systems. Coupled with the reduction of watercourse siltation is an improvement of fish habitat and general aesthetic atmosphere of unestimated value to community living.

The land treatment measures are potentially extremely effective in reducing flood peaks when the runoff originates on cultivated land. Infiltrometer studies in the Walla Walla watershed indicate an increase of 0.3 to 3.0 inches per hour in the infiltration rates by improving cover. Small watershed studies on the Pullman Erosion Experiment Station farm indicate an average annual reduction of 50 percent in flood peaks and a decrease of 1.2 inches in total annual runoff.

These watershed measurements also indicate that an average of 14.4 inches of water can be induced to enter the ground when surface conditions are kept as favorable as possible. By assuming that tillage operations can accomplish for the entire area at least half that demonstrated on the experiment station, then a reduction of 25 percent of the average annual floodwater damage is obtainable by land treatment alone. Add to this the 70 percent reduction in sediment damage and the total flood damage reduction emerges as a significant benefit caused by the land treatment program.

Rangeland

Effectiveness of the range program in reducing flood damage depends on the proportion of range area contributing to the runoff and sediment loads carried by flooding waterways. Only range lands having an erosion capability subclass were considered as the contributing area thus eliminating approximately 20 percent of the range from consideration as a part of the land treatment program.

Since the relation of range condition to erosion subclass is not direct and clear the condition class was not used in determining effectiveness of the range measures on erosion control. On-site benefits, as reflected by production increase, are claimed only from the area considered effective in flood prevention or from 80 percent of the range. An increase of 897,000 animal unit months of forage per year is the calculated increase to be brought about by application of the range treatment measures.

Forest Land

For the forest lands, with present conditions and the going program, annual timber growth equals 16.0 million cubic feet (including 30.1 million board feet, International Rule, of saw-timber). Continuation of the present program will ultimately provide an annual growth of 21.2 million cubic feet of all timber, including 49.8 million board feet of saw-timber. Adoption of the proposed program will increase growth of all timber to 21.6 million cubic feet, including 74.2 million board feet of saw-timber, each year.

Program benefits thus amount to a net increase of 0.4 million cubic feet in growth for all timber, and 24.4 million board feet for saw-timber.

Summary of Benefits from the Land Treatment Program

The estimated average annual benefit that will be obtained by the installation of the proposed land treatment program is $21,378,920. This includes estimated floodwater and sediment

damage reduction $974,212 (including 10 percent reduction of flood plain damages); conservation benefits on cropland $18,097,240; conservation benefits on rangeland $1,848,204; and conservation benefits on forest land $459,264.

EVALUATION OF THE FLOOD PREVENTION MEASURES
(A - Measures)

The monetary benefits that may be obtained by installing the proposed program of flood prevention measures on tributary streams in the area included the value of reduction in floodwater and sediment damages as well as other benefits derived from more intensive land use. The value of the reduction in flood damage was calculated as the difference in damages with, and without, the installation of the flood control measures. On the other hand, the value of other benefits through more intensive land use was based on the increase in net returns that would be realized by farm operators through increased production on flood plain lands by removal of the hazard of frequent flooding.

For evaluation purposes the area was divided into three sub-areas based on climate and previous reports.

1. The Big Bend, consisting of the plateau land of the middle and western portion of the area draining into the Columbia River.
2. The Palouse, consisting of the watershed of the Palouse River, and including the minor tributaries of the Snake River.
3. The watershed of the Walla Walla River and tributaries including a part of Umatilla County in Oregon.

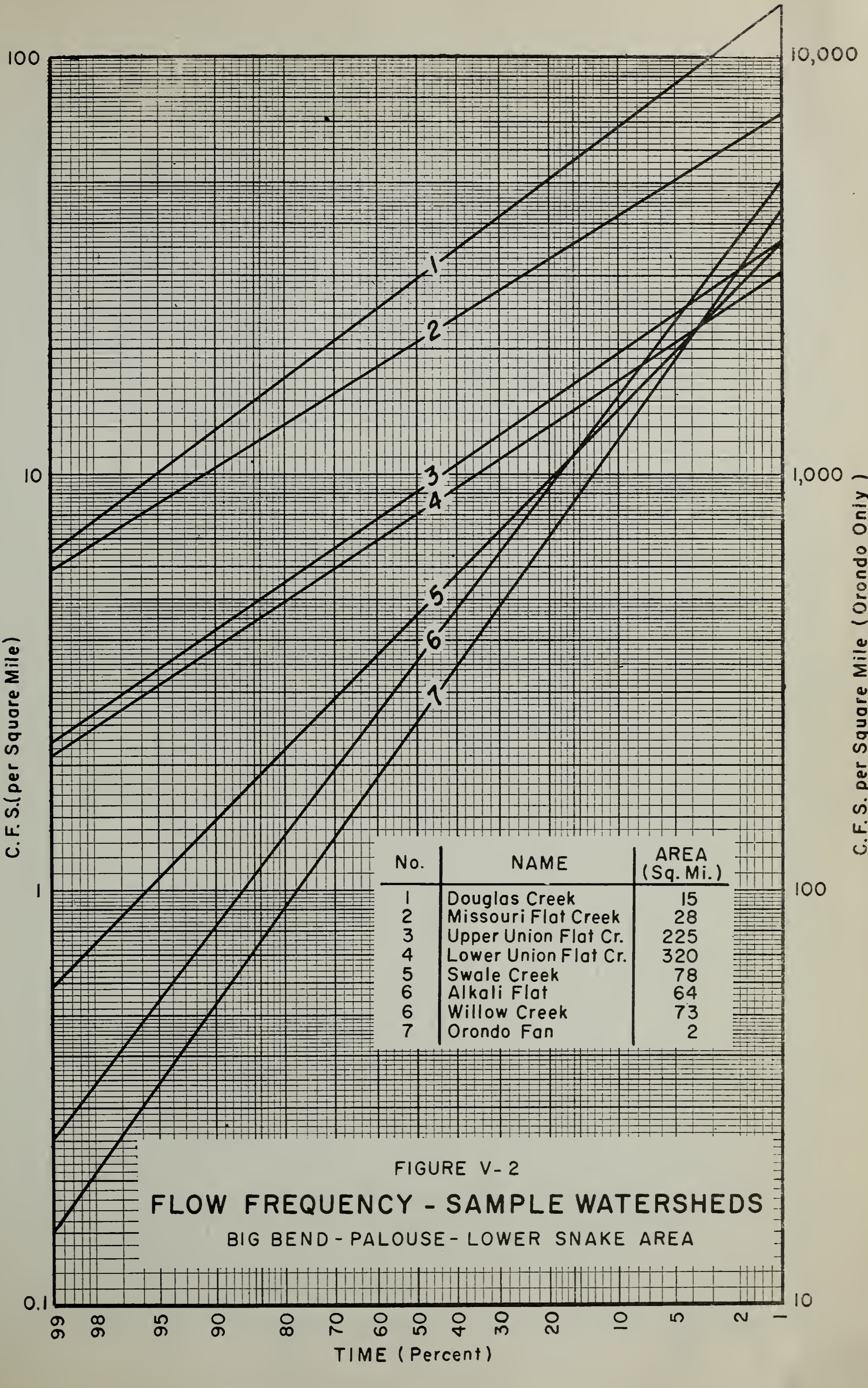
The Big Bend and Palouse Sections

Except for those sample streams in which total control is anticipated, the beneficial effect of the program is based on the relation existing between damages before and after installation of the control measures. The damage curve based on conditions before installation of controls is constructed from total damages rather than damage items; therefore, no separate determination as to the damage reduction for different classes of damage is made.

Figures V-2 to V-4 give flow frequency curves for each expanded sample and a damage-flood flow curve and a damage frequency curve for Union Flat Creek, which is used as an illustrative sample. The percent reduction of damages is the ratio of the area between the two damage curves to the total area under the damage curve based on present conditions without controls. (Figure V-3)

To arrive at the amount of the damage reduction involves consideration of indirect damages as well as an allowance for the effect of land practices on the watershed. Allowing a 30 percent increase for indirect damages and a 10 percent reduction for the land practice program gives a net increase of 17 percent over the average annual obtained from the damage survey.

The effect of the flood prevention measures was determined by plotting, for a new curve, c.f.s. obtained by taking the difference between the design flow and points on that part of the flow frequency curve above the design frequency. Damages corresponding to the flows came from the damage flood flow chart made up from original survey data, the same chart as used to plot the first damage curve.



No.	NAME	AREA (Sq. Mi.)
1	Douglas Creek	15
2	Missouri Flat Creek	28
3	Upper Union Flat Cr.	225
4	Lower Union Flat Cr.	320
5	Swale Creek	78
6	Alkali Flat	64
6	Willow Creek	73
7	Orondo Fan	2

FIGURE V-2

FLOW FREQUENCY - SAMPLE WATERSHEDS

BIG BEND - PALOUSE - LOWER SNAKE AREA

U.S. DEPARTMENT OF AGRICULTURE

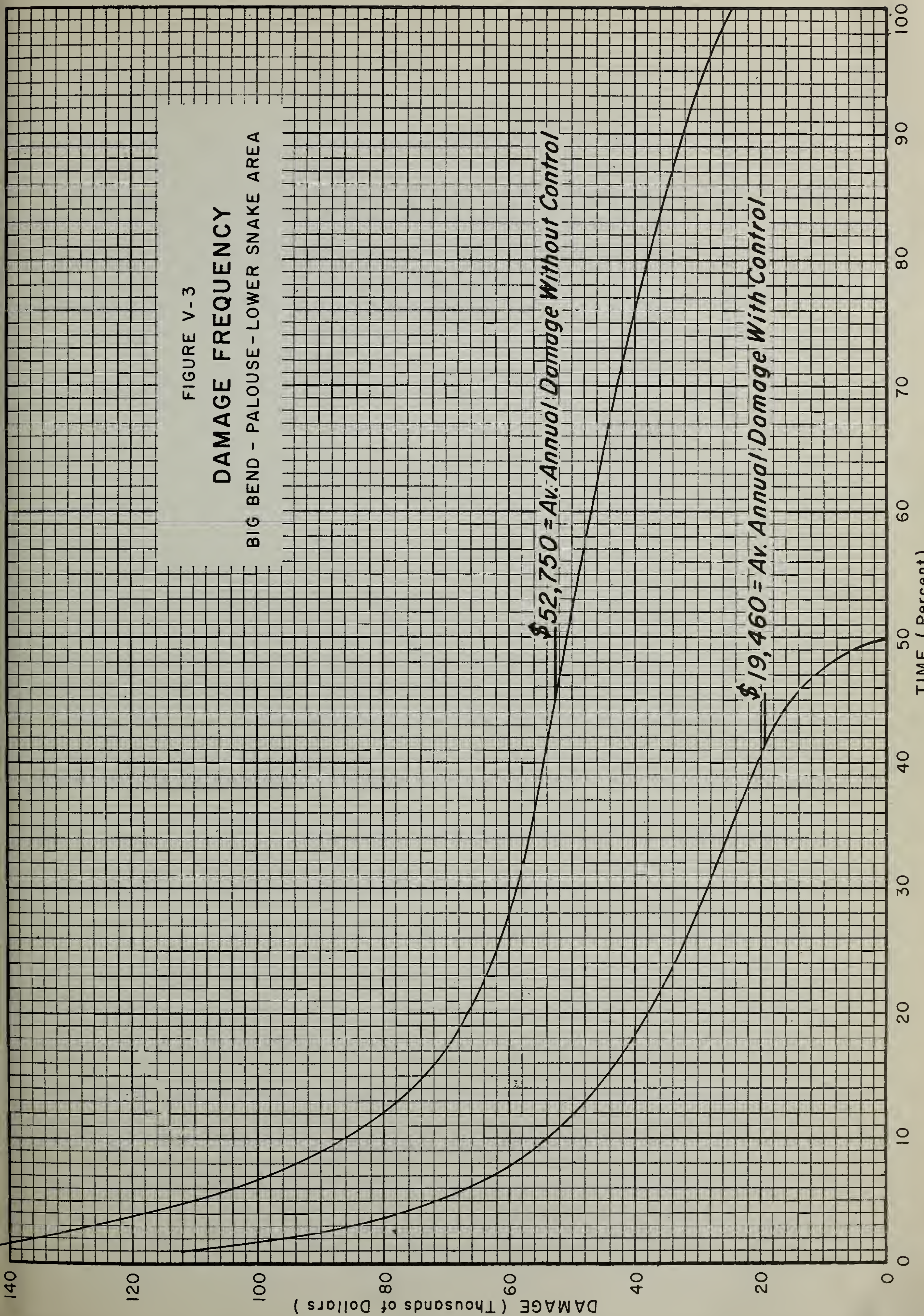


FIGURE V-3
DAMAGE FREQUENCY
BIG BEND - PALOUSE - LOWER SNAKE AREA

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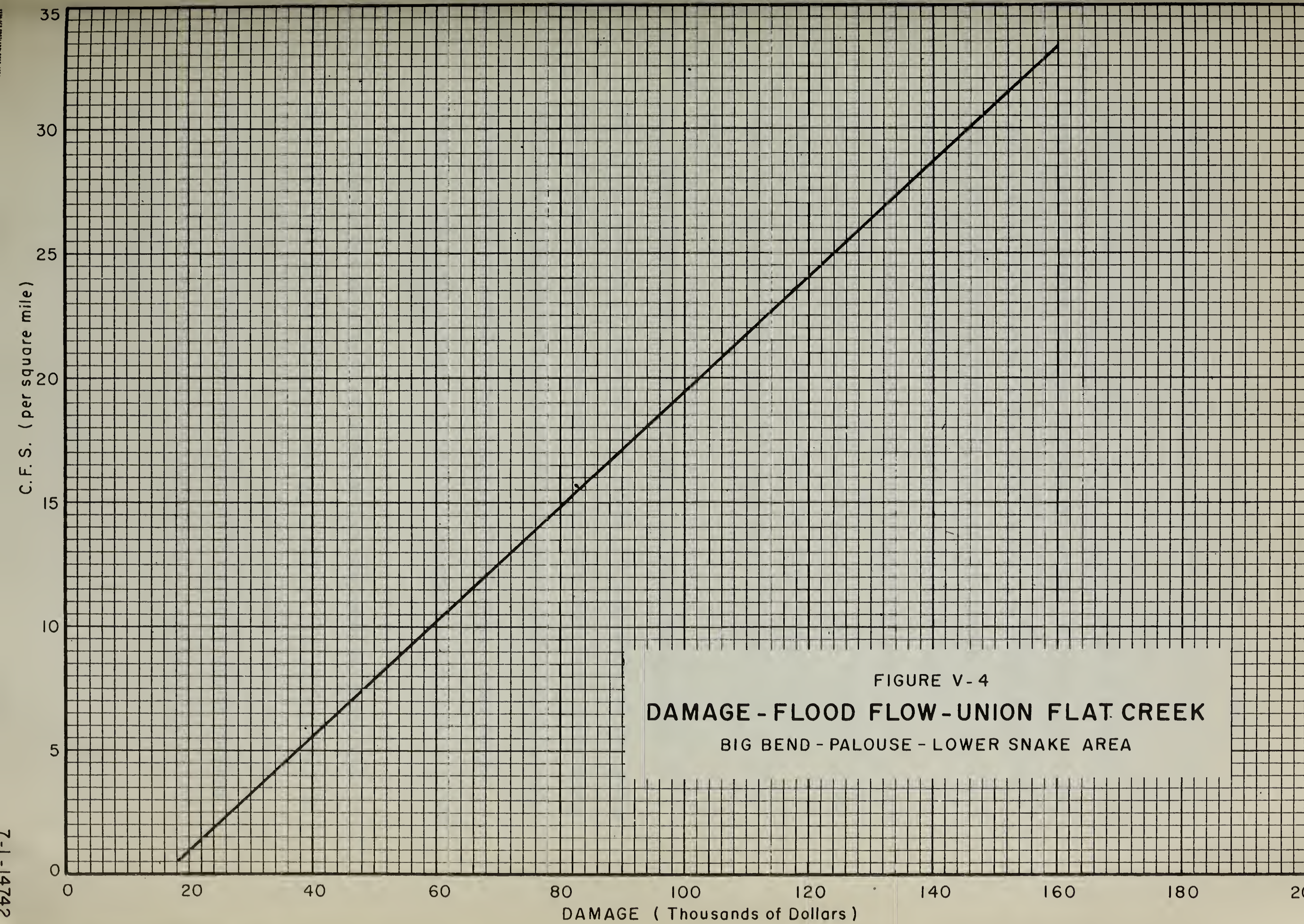
FIGURE V-4
DAMAGE - FLOOD FLOW - UNION FLAT CREEK
BIG BEND - PALOUSE - LOWER SNAKE AREA
C.F.S. (per square mile)
35
30
25
20
15
10
5
0
0
20
40
60
80
100
120
140
160
180
200
DAMAGE (Thousands of Dollars)

The area under this second curve represents the damage unaffected by the control program with reduction being the area between the two curves. Reducing this to an average annual and dividing by the present average annual damage gives the percent reduction of direct damages without the effect of the land treatment program being considered. This percent multiplied by 1.17 allows for both the increase due to indirect damages and the reduction due to the effects of the land treatment program.

Willow Creek, a sample used to illustrate control in a watershed by stabilization of a gully heading, does not lend itself to analysis by means of a damage curve for computing percent of damage reduction. The following analysis illustrates the method used:

Known facts are: (1) that about 30 years was required for the gully heading to advance 6000 feet; (2) top width of the gully varies from 50 feet at the head, to 210 feet 6000 feet downstream; (3) present channel requires about a 50 foot width for stream use. Average width of gully equals $\frac{210 + 50}{2} = 130$ feet. Loss in 30 years $= \frac{(130 - 50) \times 6000}{43,560} = 11$ acres. Average annual loss $= 11/30 = .37$ acres.

Assume the same rate of advance for the next 30 years and that 210 feet is the ultimate average width of the gully, then in next 30 years the present gully will have widened to a uniform 210 feet and the next 6000 feet will have become a gully varying from 210 to 50 feet wide, or an additional loss equal to that of the last 30 years.

Loss due to widening of present gully next 30 years equals loss of last 30 years or 11 acres $\left(\frac{[(210-50) - 8]\,6000}{43{,}560} = 11 \text{ acres.}\right)$ Loss due to elongation of gully = 11 acres. Total next 30 years = 22 acres. Annual loss (without control) = 22/30 = .74 acres.

Annual loss reduction by gully structure = .37 acres. Annual reduction with jetties by slowing side cutting in gully bottom = .37/2 = .19 acres. Total annual land loss reduction = .37 + .19 = .56 acres. Percent reduction = $\frac{.56}{.74}$ = 76%.

The annual cost and the benefit expected from the evaluation of the proposed flood prevention measures for the sample streams in the Big Bend and Palouse sections of the area are shown in Table V-6.

The damage reduction for each sample stream was then applied to like streams or portion of streams in the area outside the watershed area of the Walla Walla River to determine the benefit from the flood prevention measures. These benefits are summarized in Tables V-7 and V-8.

The Watershed of the Walla Walla River and its Tributaries

The United States Department of Agriculture has completed a survey report on the Walla Walla River watershed which includes the benefits that might be obtained by the installation of certain control measures.[1] The benefits were based on the reduction of

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1/ Report of Survey Walla Walla Watershed, Washington and Oregon, U. S. Department of Agriculture, January, 1951

Table V-6. - Summary of costs and benefit of flood prevention measures
for sample streams
1949 prices

NAME OF STREAM	COST OF FLOOD CONTROL MEASURES							ANNUAL BENEFITS			
	Total Instal-lation	Public		Private			Total Annual	Damage Reduction		Other Benefits	Total
		Install.	Annual	Install.	Annual	Main-tenance		%	$	$	
Alkali Flat	26694	21355	534	5339	214	800	1548	95	-	9686	9686
Douglas	54187	43350	1084	10837	434	1236	2754	70	7963	-	7963
Mo.Flat-Pleasant Valley	259581	207665	5192	51916	2077	5750	15773	63	15431	-	15431
Orondo	32148	25718	643	6431	257	300	1200	100	8624	-	8624
Swale	153863	123090	3077	30773	1231	4320	9828	78	27763	7935	35698
Union Flat	200075	160060	4002	40015	1601	7611	13214	60	36925	11879	48604
Walla Walla	2400928	1920742	48018	480185	19207	62000	129225	-	108810	93826	202636
Willow	14613	11690	292	2923	117	250	659	76	213	474	687

Table V-7. - Summary of estimated average annual monetary benefits from damage reduction by flood prevention measures* - Big Bend Section 1949 prices

Type of Benefit	Average Annual Benefit	
Reduction in Floodwater Damage		
Crops	$5352.50	
Property	4527.54	
Land Loss	7276.41	
Miscellaneous	2465.59	
Subtotal		$19,622.04
Reduction in Sediment Damage		
Crops and Property	667.73	
Land	62,055.47	
Miscellaneous	6,471.72	
Subtotal		69,194.92
Reduction in Floodwater & Sediment Damages		
Farm Roads and Bridges	908.08	
Farm Irrigation and Drainage Systems	381.98	
Miscellaneous	816.12	
Subtotal		2,106.18
Total Benefits		$90,923.14

* Estimated benefits after reducing damages 10 percent, allocated to land treatment measures.

Table V-8. - Summary of estimated average annual monetary benefits from damage reduction by flood prevention measures* - Palouse Section
1949 prices

Type of Benefit	Average Annual Benefit			
	Washington		Idaho	
	$	$	$	$
Reduction in Floodwater Damages				
Crops	70,379.39		10,515.90	
Property	14,041.19		923.63	
Land	18,123.40		2,355.77	
Subtotal		102,543.98		13,795.30
Reduction in Sediment Damages				
Crops & Improvements	7,303.23		892.82	
Land	7,105.35		363.72	
Subtotal		14,408.58		1,256.54
Total Benefits		116,952.56		15,051.84

* Estimated benefits after reducing damages 10 percent, allocated to land treatment measures.

floodwater and sediment damages, and other incidental benefits from water conservation and from potential irrigation. All damages and benefits were evaluated at the price levels that prevailed in 1947. Damage values were converted to 1949 price levels by means of Indices.[1/] The same percentage reduction in damages as existed in the Walla Walla Report was used to determine benefits from reduction in floodwater and sediment damages at 1949 price levels for this report. Benefits that might be expected from reduction in floodwater and sediment damages by the installation of the flood prevention measures are shown in Table V-6 and Table V-9.

Summary of Flood Damage Reduction Benefits from Flood Prevention Measures

The benefits that will accrue to farm owners and operators in the Big Bend-Palouse-Lower Snake area from the installation of the proposed flood prevention measures through the reduction in floodwater and sediment damages are summarized in Table V-10.

Evaluation of Benefits from More Intensive Land Use Due to Reduction in Flood Hazard

The program for reduction of floodwater and sediment damages to crops, property and agricultural lands along the various tributary stream channels in the area will provide other benefits in

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1/ Conversion factor of .86 was used; it was obtained from the ratio of prices paid 1947 - 1949 to prices received 1947 - 1949, using "Index of Prices Paid by Farmers, Interest, Taxes, Wage Rates" and "Index of Prices Received by Farmers" - Revised Jan. 1950, Bureau of Agricultural Economics.

Table V-9.--Estimated average annual flood damages in special problem areas (along tributary streams) and annual benefits of proposed control measures Walla Walla Watershed - 1949 prices

	Washington		Oregon	
	Damages* 1949 prices $	Benefits** $	Damages* 1949 prices $	Benefits** $
Reduction in Damage to -				
Crops, Property and Improvements a/	29,275.20	27,752.89	2,400.00	2,275.20
Land Loss b/	1,954.80	1,853.15	337.20	319.67
Loss due to Desiccation of Valley c/				
Present Loss	38,018.40	36,041.44	-	-
Future Loss - 50 years	24,348.00	23,081.90	18,445.20	17,486.05
Total	93,596.40	88,729.38	21,182.40	20,080.92

* Includes Indirect Damages equal to 20 percent of Direct Damages.

** Benefits based on reduction of damages of 94.8 percent as shown in The Walla Walla Report.

a/ Entered in Summary of benefits as reduction in "floodwater damage" to "property".

b/ Entered in Summary of benefits as reduction in "Floodwater damage" to "Land".

c/ Entered in Summary of benefits as reduction in "Floodwater damage" to "Crops".

Table V-10.--Summary of average annual monetary benefits from flood damage reduction by flood prevention measures (A Measures) (long-term prices)

Type of Damage	Estimated Average Annual Benefit	
	dollars	
Floodwater Damage		
Crops	102,284	
Property	31,757	
Land Loss	18,102	
Farm Roads and Bridges	191	
Farm Irrigation and Drainage Systems	104	
Other Agricultural	1,731	
Irrigation and Drainage Systems - Off Farm	1,874	
Public Roads and Railroads	107,678	
Other Downstream Damages	68,904	
Subtotal		332,625
Sediment Damage		
Crops and Improvements	5,336	
Land	41,854	
Farm Irrigation and Drainage Systems	127	
Farm Roads and Bridges	356	
Other Agricultural	4,142	
Stock Ponds and Reservoirs	-	
Irrigation and Drainage Systems - Off Farm	2,396	
Public Roads and Railroads	91,747	
Other Downstream Damages	22,016	
Subtotal		167,974
Reduction of Indirect Damages		97,838
Total Damage Reduction		598,437

addition to flood damage reduction. The additional benefits will accrue to farm operators through the more intensive use and increased production on areas subject to swamping, inundation and overflow. The damage survey was largely confined to the evaluation of the destructive effects of floodwater and sedimentation resulting in crop loss, property damage, and land destruction. The flood prevention measures set up for these tributary streams were largely designed to prevent these damages by reducing the area subject to inundation and overflow, as well as the frequency of such occurrences. As much of the land is now producing below its normal productive capacity due to frequency of flooding, the reduction in such occurrences will make possible increased returns through the application of proper farm management practices. The degree to which increased returns from more intensive use of the flood plain lands may be realized will vary from nothing on certain streams to amounts equal to or greater than the benefits from flood damage reduction on other tributaries.

Situations that give rise to benefits from more intensive land use may be grouped under four general types.

First, in areas where frequent flooding has caused considerable damage by reduced crop yields as shown in the section on "Floodwater and Sediment Problems." Consequently, considerable benefits can be expected from the channel program in these areas for this item. However, in addition to the benefits from a reduction in the frequency of flood occurrences and more rapid removal of floodwaters there will be another benefit through

increased production made possible by the application of crop rotations and better farm management practices.

The second condition found on the flood plains of certain streams is the frequent flooding and overland flow which has prevented the cultivation of adjacent lands. These areas are generally relegated to brush pasture. The removal of the hazard of frequent flooding will make possible the cultivation and reseeding of these lands for improved pastures and hay production in rotation with an occasional cultivated crop.

The third condition that gives rise to additional benefits occurs where the bottom land areas along certain streams are subject to frequent overflow of floodwater, but do not cause floodwater damage. These flood plain areas are generally in a cover of native grass and weeds producing forage of low value. The reduction of the areas subject to frequent inundation would remove one of the factors preventing the cultivation and profitable production of crops. A portion of the increase in net returns could be attributed to removal of the flood hazard.

The fourth situation where other benefits will occur from the installation of control measures is when the damage values based on the historical record of damage occurrences, from which benefits are calculated, do not properly reflect the increased amount of damages that will take place if the control measures are not installed. The increased amount of future damages over and above the historical rate might well have been included as potential damage in the damage evaluation. However, as these areas

are limited and of minor importance in the over-all damage picture, they were not included as damages, but are considered as benefit from prevention of potential damages.

The above conditions giving rise to other benefits were generally confined to certain types of streams in the Big Bend and Palouse sections of the area. In that portion of the area consisting of the Walla Walla watershed no additional evaluation of other benefits was made outside the benefits for "incidental water conservation" and from "potential irrigation" as shown in the survey report of the Walla Walla watershed.

In general, the value of the "other" benefits on flood plain areas resulting from the establishment of flood prevention measures was considered to be the increase in net returns from crops grown, after the effect of the control program on floodwater and sediment damages had been evaluated. The analysis of these other benefits was made on the same sample streams used for the determination of floodwater and sediment damages. At the time of the damage inventory, basic data as to the area subject to overflow, the crops grown, and average yields, were obtained, as well as the floodwater and sediment damage that had occurred. It was from this data that the evaluation of other benefits was made. The program to reduce floodwater damages in the Big Bend and Palouse sections made possible other benefits on the following streams.

<u>Swale Creek sample</u> This sample stream was found to contain approximately 1,770 acres of land subject to inundation by

floodwater. Frequent flooding has caused considerable damage by reducing crop yields, as shown in the section on floodwater damages. Consequently, considerable benefits are shown due to the prevention of frequent flooding by the channel program as shown in Table V-6. A reduction in the frequency of flood occurrence and more rapid removal of floodwater will make it possible for the farm operators to increase production through crop rotation and better farm management practices. This additional benefit would amount to an annual figure of $7,935 for this stream. Table V-11 shows the present crops grown, estimated yields and weighted average net returns per acre received under present conditions. Also, in this table are the estimated yields, and average weighted net returns per acre after the installation of the channel program. Net income values were obtained from typical farm budgets and net income graphs.

The difference in net returns with and without a program represents the total benefit of the proposed measures. However, as a portion of the increase in net returns was designated as damage from depressed crop yields in the damage survey, it was necessary to deduct this damage item in order to obtain the net benefit due to more intensive land use. The additional benefits expanded to other flood plain areas classified similar to Swale Creek would provide annual benefits in the amount of $1,075.

<u>Lower Union Flat Creek sample.</u> The lower reach of Union Flat Creek used as a sample stream contains approximately 2,178 acres of bottom land subject to overflow. This area has some 577 acres

Table V-11. - Estimated production and net return on Swale Creek sample watershed, with and without a program (1949 prices)

PRESENT PRODUCTION, LAND USE AND NET RETURN

Crops	No. of Acres	Yield Per Acre	Net Return Per Acre	% of Crop	Weighted Net Return
			Dollars		Dollars
Oats	531	40 bu.	10.21	30%	3.06
Wheat	35	25 bu.	24.32	2%	.49
Hay	106	1 Ton	10.94	6%	.66
Pasture	1098	2.5 AUM	16.92	62%	10.37
Total	1770			100%	14.58

FUTURE LAND USE, PRODUCTION AND NET RETURN WITH A PROGRAM

Crops	No. of Acres	Yield Per Acre	Net Return Per Acre	% of Crop	Weighted Net Return
			Dollars		Dollars
Wheat	708	35 bu.	40.72	40%	16.29
Hay	531	2 ton	28.60	30%	8.58
Pasture	531	4 AUM	27.97	30%	8.39
Total	1770			100%	33.26

Increase in Net Return Per Acre	$ 18.68
Number of Acres - Flooded Area	1770
Total Increase in Net Return	$33,063.60
Floodwater Damage - Reduced Yields	25,128.44 1/
Net Benefit Due to More Intensive Land Use	7,935.16
Per Acre Benefit Due to More Intensive Land Use	4.48

1/ SOURCE - Unpublished data Damage Survey of Swale Creek Sample Stream - Floodwater and Sediment Damages, Yakima-Okanogan Area, Columbia Basin.

of land classed as brush pasture. About 342 acres of this damage type was covered with rather dense brush upon which little damage had occurred. It is used mainly as brush pasture. The channel program, if installed, would make possible other benefits from the clearing of this land for production of cultivated crops along with grass and legume hay and pasture. The calculation of the estimated benefits would amount to an annual figure of $6,540 as shown in Table V-12. The reach in Union Flat Creek covered by this sample was considered to be unlike other streams in the area and not subject to expansion to other streams or portions of streams.

Middle Section of Union Flat Creek. That portion of Union Flat Creek designated as the Middle Section used for a sample stream to determine damages and benefits contains approximately 1,354 acres of land subject to overflow. Data obtained during the damage survey indicated that 29 percent, or 349 acres, were in a cover of brush and pasture. Of this area, approximately 243 acres with a heavy cover of brush could be cleared and seeded to permanent stands of legume hay and pasture (with an occasional cultivated crop) if the program of channel improvement were installed. Benefits from increase in net returns through more intensive land use shown on Table V-13 amounts to $5,339. These benefits were added to the other benefits determined for the lower section of Union Flat Creek, making a combined figure of $11,879 for both samples. As the program of improvement designed for Union Flat Creek included both middle and lower sections, it was necessary to

Table V-12. - Estimated production and net return on the brush areas of lower Union Flat watershed, with and without a program (1949 prices)

PRESENT USE, PRODUCTION AND NET RETURN				
Crop	No. of Acres	Yield Per Acre	Net Return Per Acre	Total Net Return
			Dollars	Dollars
Brush	342	1 AUM	5.47	1,870.74

POTENTIAL USE, YIELD AND NET RETURN WITH A PROGRAM				
Crop	No. of Acres	Yield Per Acre	Net Return Per Acre	Total Net Return
			Dollars	Dollars
Wheat	68	30 bu.	33.12	2,252.16
Barley	103	40 bu.	22.80	2,348.40
Grass and Legume Hay	85	2 ton	28.60	2,431.00
Improved Pasture	86	4 AUM	27.97	2,405.42
Total	342			9,436.98

Total Net Increase - $7,566.24

Cost of Clearing, estimated $75.00 per acre
Annual charge at 4% 3.00
3.00 x 342 = 1,026.00
7,566.24 - 1,026.00 = $6,540.24

Table V-13. - Estimated production and net return on the brush pasture areas on the middle section of Union Flat Creek watershed, with and without a program (1949 prices)

PRESENT USE, YIELD AND NET RETURN

Crops	No. of Acres	Yield Per Acre	Net Return Per Acre	Total Net Return
			dollars	dollars
Brush pasture	243	75 AUM	3.68	894.24

POTENTIAL USE, YIELD AND NET RETURN WITH A PROGRAM

Crops	No. of Acres	Yield Per Acre	Net Return Per Acre	Total Net Return
			dollars	dollars
Barley	24	40 bu.	22.80	547.20
Wheat	24	30 bu.	33.12	828.00
Grass and Legume /Hay	97	2 ton	28.60	2,774.20
Pasture	97	4 AUM	27.97	2,713.09
Total	243			6,962.49

Increase in Net Return - $6,068.25

Cost of clearing 75.00

Annual charge at 4% 3.00

3 x 243 = 729

$6,068.25 - $729.00 = $5,339.25

combine the benefits of the program to be consistent with the flood control program developed for this stream as shown in Table V-6. However, the benefits from more intensive land use determined for the Middle Section of Union Flat Creek sample were expanded tc other streams in the Palouse section similarly classified, making a total benefit of $13,906.

Alkali Flat Creek. This sample stream consists of a rather broad flat valley (up to a width of one-half mile) extending for a distance of 13 miles along Alkali Flat Creek. The flood plain area consists of approximately 1,842 acres of bottom land subject to annual overflow. About 76 percent of this area (1,402 acres) is in a cover of salt grass and weeds and is used for pasture. On a portion of the area a serious alkali condition exists. The frequent flooding results in little or no floodwater and sediment damages. However, considerable benefits through more intensive land use could be obtained if the annual flooding were prevented and the alkali condition improved. Table V-14 shows the present production and net returns, and that which might be expected under improved conditions. As the flood control problem was only part of the total problem, 50 percent of the total benefits was allocated to reduction in flooding. This portion of the total benefits amounted to $9,686. This was the only stream of this nature in the Palouse section. However, it was expanded to like areas in the Big Bend section of the area resulting in a total benefit of $10,080 for that section.

Table V-14. - Land use, production and net return on Alkali Creek watershed with and without a program (1949 prices)

PRESENT PRODUCTION AND NET RETURN WITHOUT A PROGRAM				
Crops	No. of Acres	Yield Per Acre	Annual Net Return Per Acre	Annual Total Net Return
			dollars	dollars
Pasture (salt-grass)	1402	.5 AUM	1.89	2649.78
Winter wheat	396	30 bu.	18.59	7361.64
Irrigated hay	44	3 ton	20.57	905.08
Total	1842			10916.50

POTENTIAL USE, YIELD AND NET RETURN WITH A PROGRAM				
Crops	No. of Acres	Yield Per Acre	Net Return Per Acre	Total Net Return
			dollars	dollars
Improved pasture	719	2 AUM	12.97	9325.43
Winter wheat	1079	30 bu.	18.59	20058.61
Irrig. alfalfa hay	44	3 ton	20.57	905.08
Total	1842			30289.12

Annual increase in net return - $19,372.62

Estimated percent attributed to Flood Control Measures - 50%

Annual benefits due to Flood Control Measures - $9,686.31

Annual per acre benefits due to Flood Control Measures - $5.25

Willow Creek sample. The floodwater damage on that portion of Willow Creek covering the stream reach of relatively rapid entrenchment, was based on the historical record of land and crop losses and property damage from floodwater. It is evident that further progression of the entrenchment would destroy more valuable land and property, resulting in increased annual damages. As the damage evaluation did not take into account the increased value from further damage, an examination of the area subject to further entrenchment was made and the potential damages over and above the historical rate were evaluated. The average annual value of the benefits for prevention of potential damages amounted to $474 as shown in Table V-6. When expanded to like reaches of other streams there would be a total benefit of $1,422 from this item in this area.

Walla Walla Watershed. Benefits other than those resulting from the reduction of floodwater and sediment damage in the Walla Walla Watershed as determined in the survey report of the Walla Walla River were confined to benefits resulting from increased storage of water. In the survey report they were listed as "Incidental Water Conservation" and "Potential Irrigation". As these benefits were evaluated at the price levels existing in 1947 it was necessary to adjust to the 1949 price base to be consistent with this report. Table V-15 shows the value of other benefits in the Walla Walla Watershed and the adjusted values at 1949 prices.

Table V-15. - Estimated average annual benefits from water storage - Walla Walla watershed*

Type of Benefit	1947 Price Base	1949** Price Base
	dollars	dollars
Incidental Water Conservation	21,700	18,662
Potential Irrigation	87,400	75,164
Total Benefits	109,100	93,826

* Source: Report of Survey Walla Walla watershed, Washington and Oregon, January 1951, Appendix V.

** Adjustment to 1949 price level.

Summary of Benefits from More Intensive Land Use

The estimated average annual benefits from more intensive land use which will be obtained as a result of the installation of the flood prevention measures is $117,418.

Summary of Benefits from the Recommended Program

Table V-16 summarizes the estimated average annual benefit that will be obtained by the installation of the recommended program.

COMPARISON OF BENEFIT AND COST

The ratio of the estimated average annual monetary benefit of $715,855 to the estimated average annual value of the total cost of $337,045 of the Flood Prevention measures (A Measures) is 2.12 to 1.

The ratio of the estimated a verage annual monetary benefit of $21,378,920 to the estimated average annual value of the total cost of $13,078,987 of the Land Treatment measures (B Measures) is 1.63 to 1.

The ratio of the estimated average annual monetary benefit of $22,094,775 to the estimated average annual value of the total cost of $13,416,032 of the total program (A and B Measures) is 1.65 to 1.

These ratios have been computed on the basis of long-term projected prices.

Refer to Table V-17 - Comparison of average annual benefits and costs of the recommended program.

Table V-16.—Average annual benefit from the recommended program (Long-range projected prices)

	"A" Measures	"B" Measures	Total
	Dollars	Dollars	Dollars
Reduction of Floodwater Damages			
Crops	102,284	32,537	134,821
Property	31,757	11,394	43,151
Land Loss	18,102	17,410	35,512
Farm Roads & Bridges	191	3,599	3,790
Farm Irrigation & Drainage Systems	104	167	271
Other Agricultural	1,731	2,502	4,233
Irrigation & Drainage Systems - Off Farm	1,874	540	2,414
Public Roads & Railroads	107,678	99,729	207,407
Other Downstream Damages	68,904	13,223	82,127
Subtotal	332,625	181,101	513,726
Reduction of Sediment Damages			
Crops & Improvements	5,336	292,553	297,889
Land	41,854	6,021	47,875
Farm Irrigation & Drainage Systems	127	239	366
Farm Roads & Bridges	356	18,573	18,929
Other Agricultural	4,142	2,157	6,299
Stock Ponds & Reservoirs	-	3,546	3,546
Irrigation & Drainage Systems - Off Farm	2,396	1,115	3,511
Public Roads & Railroads	91,747	332,900	424,647
Other Downstream Damages	22,016	3,306	25,322
Subtotal	167,974	660,411	828,385
Reduction of Indirect Damages	97,838	132,700	230,538
Total Damage Reduction	598,437	974,212	1,572,649
Other Benefits			
More Intensive Land Use	117,418	-	117,418
Conservation of Cropland	-	18,097,240	18,097,240
Conservation of Rangeland	-	1,848,204	1,848,204
Conservation of Forest Land	-	459,264	459,264
Total Benefits	715,855	21,378,920	22,094,775

Table V-17. - Comparison of average annual benefits and costs of the recommended program (long-term prices)

Item	Costs			Benefits				Benefit Cost Ratio
	Federal	Non-Federal Public	Total	Flood Damage Reduction	More Intensive Use of Land	Conservation	Total	
Flood Prevention Measures								
Total installation	4,850,090	1,529,118	6,379,208					
Average annual installation 1/	171,014	54,131	225,145					
Operation, maintenance and replacement	7,849	104,051	111,900					
Total average annual equivalents	178,863	158,182	337,045	598,437	117,418	-	715,855	2.12
Land Treatment Measures								
Total installation	5,591,083	44,500,948	50,092,031					
Average annual installation 1/	197,142	2,071,519	2,268,661					
Operation, maintenance and replacement	153,044 2/	10,657,282	10,810,326					
Total average annual equivalents	350,186	12,728,801	13,078,987	974,212	-	20,404,708	21,378,920	1.63
Grand Total - Average Annual Equivalents	529,049	12,886,983	13,416,032	1,572,649	117,418	20,404,708	22,094,775	1.65

1/ $2\frac{1}{2}$% interest rate for Federal and non-Federal public costs and 4% for private costs.

2/ Includes $110,000 for annual cost of accelerated educational assistance.